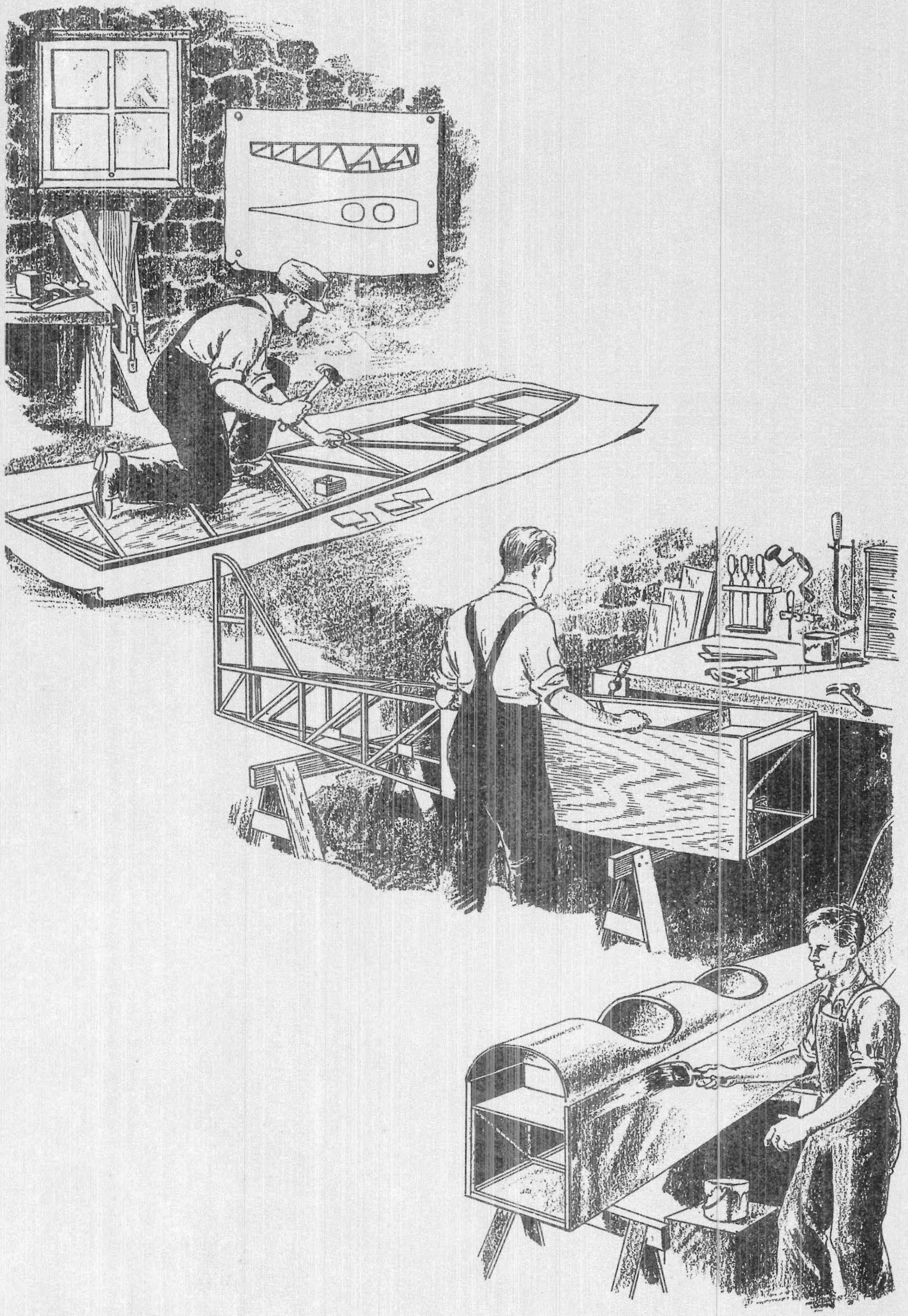


FLYING AND GLIDER MANUAL "The Sportplane Authority of America" 1932 edition, was originally published by MODERN MECHANICS AND INVENTIONS, A Monthly Magazine of Science and Invention/FAWCETT PUBLICATIONS, INC., Minneapolis, Minnesota.

EXPERIMENTAL AIRCRAFT ASSOCIATION, INC. / EAA AIR MUSEUM FOUNDATION, INC. / FRANKLIN, WISCONSIN

worst possible flight condition.

As to the fittings: look at the illustrations here. A number of suggestions are given. Plywood gusset plates, all wood fuselages, metal fittings made from bolts, or from cheaply procurable cold rolled steel are all shown, and suggest many ways in which the ingenious homebuilder can hurdle the obstacle of the homebuilt wooden fuselage. One picture in this connection is worth a thousand words, and let me again say that wooden fuselages are still practical.

How to Wrap Shock Cord

Darned few grease monks these days know how to wrap up an old-fashioned shock cord absorber on an ordinary straight axle.

Here's the prescription: One end is secured to the axle. The winding is started across, under, over, under and across the axle as the drawing shows. Each "bight" of cord is stretched to its tightest possible limit. You can loosen it later if the plane is too bouncy. The drawing tells the rest. Note, too, how the ends are sewn up.

Suggested Spar Design

In the air races of 1925 many little planes were exhibited which were the equal of anything we have today in this field. Had the builders of those recent years had the ready acceptance on the part of the public that Ed Heath and Jim Church have capitalized on, no doubt they would be accepted designs today. Among one of the most interesting of these little ships was the Kreider Resiner Midget.

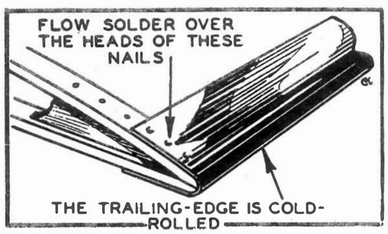
The singular feature of this ship was the rigid single spar wing built around the M-6 (constant center of pressure) wing. A look at the drawing and the diagram will show how the wing was constructed for extreme rigidity and light weight.

Motor Mount for a V-Twin Engine

Back in the heyday of Ed Heath, when he first started to use motorcycle motors in light airplanes, there were many awkward ways in which the guts of these steel steeds were adapted to air use.

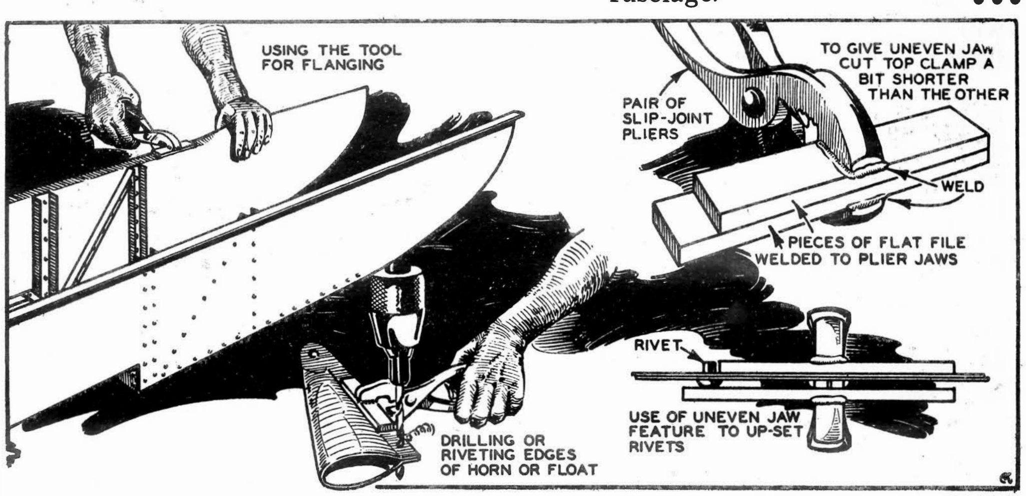
Two of the mounting methods are shown in the drawing. Where tubes could be run through the engine the style of mounting shown on top can be used. Where the motor has two bolt clips as was the case with the Harley and Indian motors, the double bulkhead style of mounting can be used, using tubing shims against washers to hold the motor rigid in a double bay at the end of the fuselage. • • •

LIGHT AIRPLANE BUILDING IS SIMPLIFIED BY THESE TIME-SAVING WRINKLES



METAL TRAILING EDGE

In the fastening of metal trailing edge to wooden ribs a good method for the anchorage of the fastenings must be provided. It is the practice of most large airplane companies to use a galvanized trailing edge. This can be soldered nicely. When sinking in the small brads, all that is needed to anchor them is to file them flush with the metal and then sweat in a little solder, taking care to see that the acid is all cleaned out and that the metal is clean before the solder is flowed. In the event of an aluminum trailing edge being used, the same procedure may be followed, but a good grade of aluminum solder should be used.



Crimping and rivet setting are two operations for which no maker has marketed a tool. Here is one which will perform both these operations. It is made by welding annealed file stock to a pair of pliers, as shown in the drawing. One end is kept short for pressing the metal down around the rivet.

HANDY KINKS
FOR THE
PLANE BUILDER

Hi, gang! Here we are again, talking about the downtrodden homebuilder of airplanes and how he can evade the need for steel construction in building that backyard hedge hopper.

Now steel is all right — for those who can use it and for those who can afford it. In fact, it is the best form of construction known. But—we mustn't forget that men have been flying in wooden fuselages longer than in steel, and we mustn't forget that wood is the cheapest, most easily built fuselage of them.

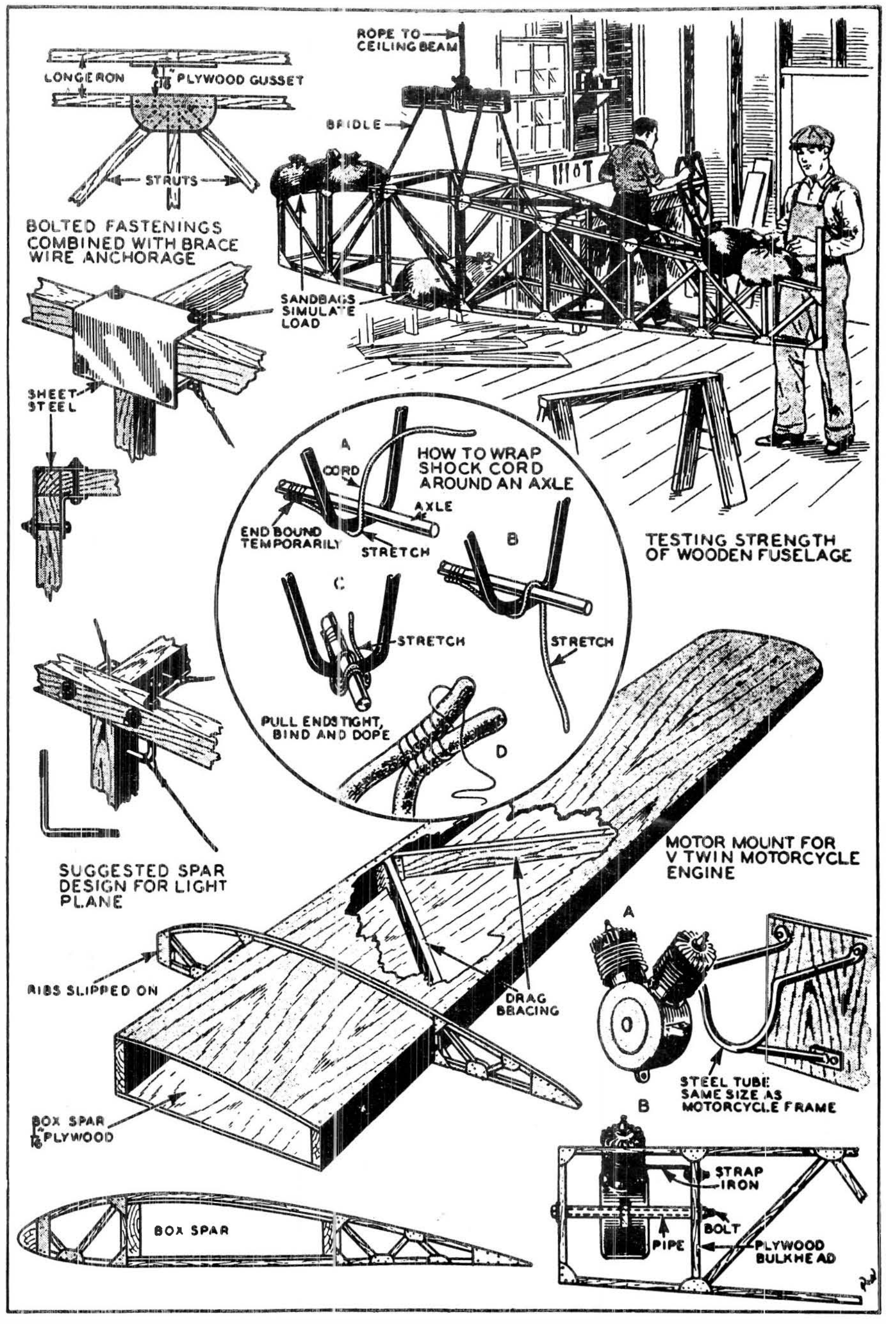
One inch by one inch longerons on a length of not over 18 ft., made of white oak or clear grained ash of close knitting, will hold a Ford engine, and fly about 600 lbs., gross weight. The old Jenny, weighing about 1,600 to 1,800 lbs., as I remember it, had ash longerons about 1¼ by 1¼ in. The bottom longerons are generally in tension and the top ones generally are in compression. They are braced by suitable baying so that they assume the loads imposed on them in line and do not wobble.

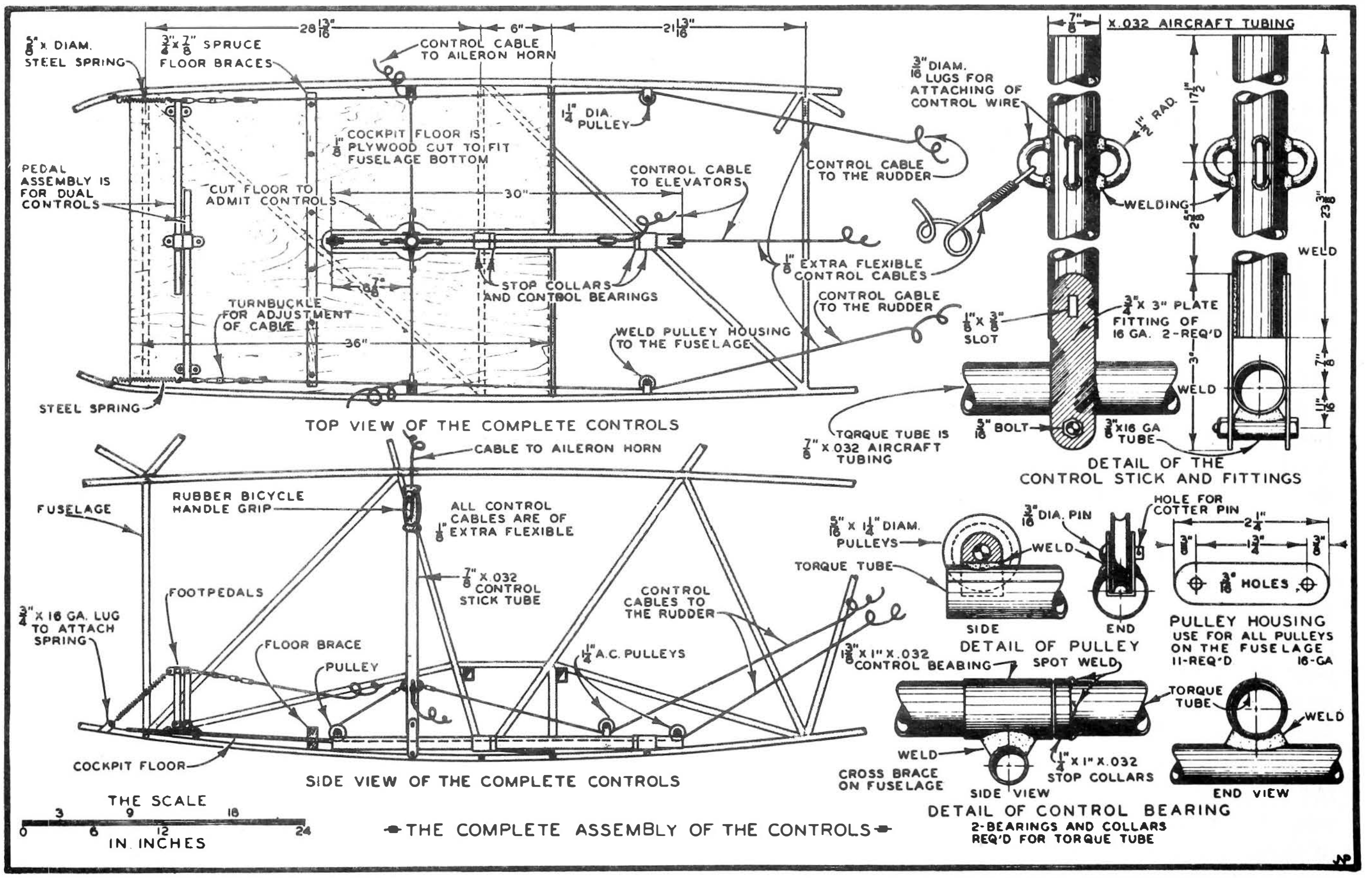
The main stumbling block in making such a fuselage is found in the questions, "How strong will it be?" and, "What kind of fittings shall I use?"

Exactly why this is written. First off, if the fuselage when done will stand a static load of seven times what it is planned to carry in normal flight, it will conform to what pre-Dept. of Commerce designers were wont to consider "beaucoup ample." The drawing shows how the fuselage is loaded against gravity as though she were in flight.

Bags of sand are gingerly placed on the loading spot to correspond to the load multiple of seven, or put on until a noticeable strain takes place. The sand can then be removed and weighed, the load that the fuselage will safely stand thus being predetermined. As the load factors in the air due to acceleration in coming out of a dive, etc., are but four, if you have a factor of seven for a static load you have a safety factor of 7/4 over the

. . . *continued*

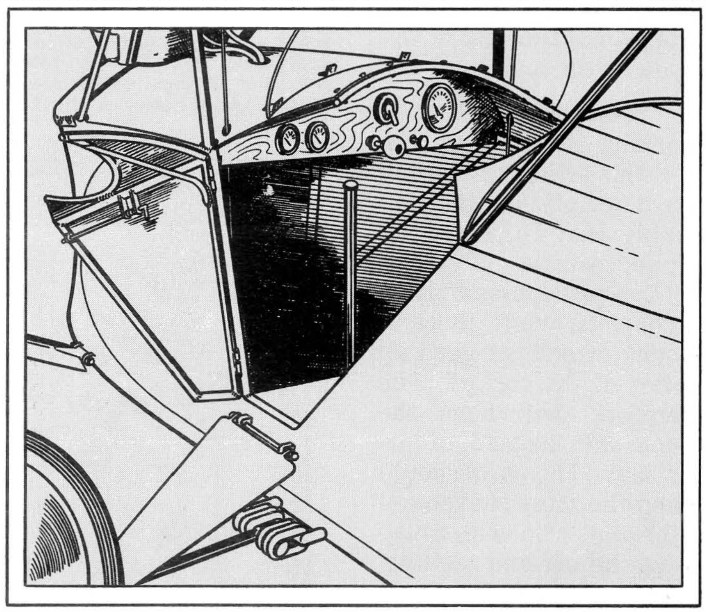




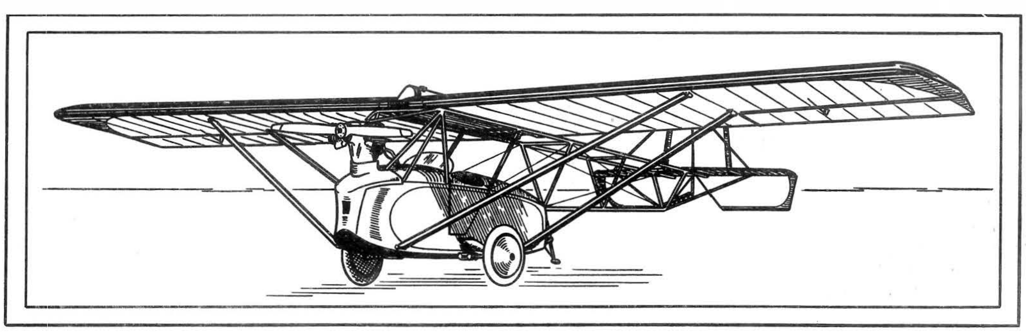
plenty of time, get everything correct, and a good flying ship will be your reward.

Covering and Doping

This procedure should be carried out by the envelope method wherever possible, and the open edges hand sewed. Use three coats of clear dope and two of pigmented dope, applying the first coat with either a brush or a low pressure spray gun. Be sure the first coat thoroughly penetrates and fills the fabric and that all other coats thoroughly cover. Doping should be done under fairly warm conditions and each coat permitted to dry before further application. • • •



This photo, looking into the cockpit from the left rear, offers suggestion for placing the plywood instrument board.



Finish the job so your plane will present a smart appearance. The original "Bathtub" is trim.

and lining up by hand, bending cold, for there is little bending to be done, you will get a perfect job.

There is quite a trick to heating a steel tube in the proper place to get the right results. Heat the tube on the side which is to be bent to a dull red. At first this actually increases the bend, but when the tubing cools off you will find that it has assumed an angle opposite to the original bend, and almost invariably comes out exactly right.

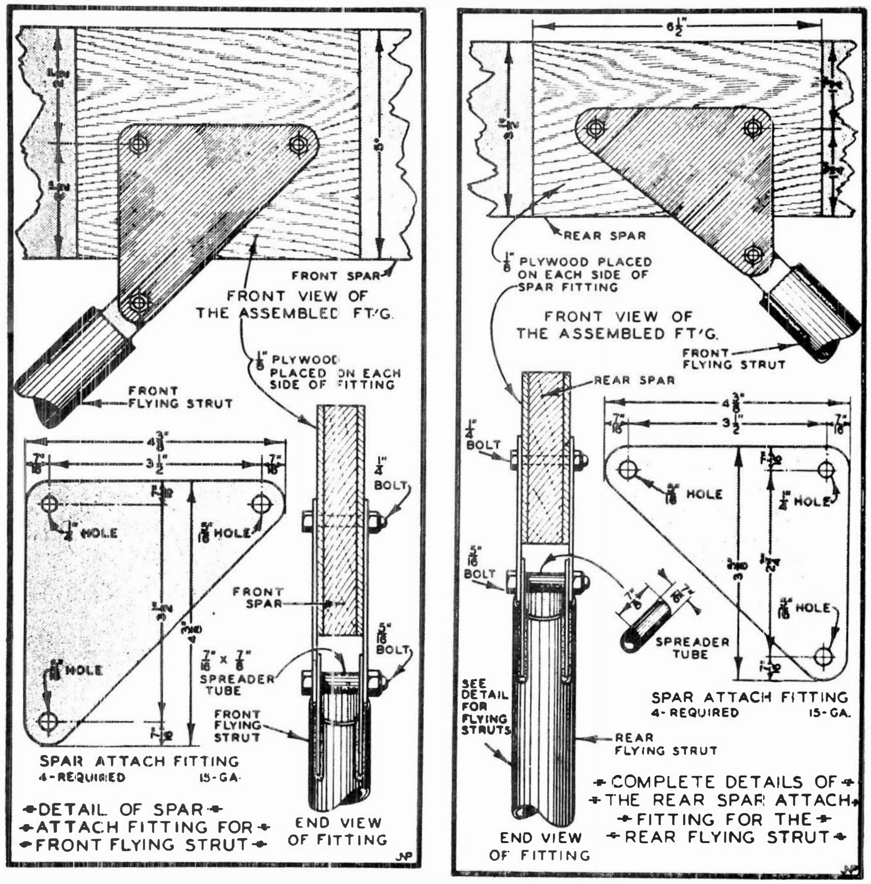
In handling small tubing, extreme care must be taken not to get the metal too hot and burn the tubing. It is easy to tell if the weld is good. If it is so clean that it looks as if new metal had been placed there the job is okay. A poor weld has a sand effect on the outside and is very scaly. If these faults show up, throw that piece away and build a new piece. It is for this reason that I advise that you call in a welder for a couple of days if you can't do a good job yourself. The man's wages could easily be less than the cost of the material you might spoil.

Controls

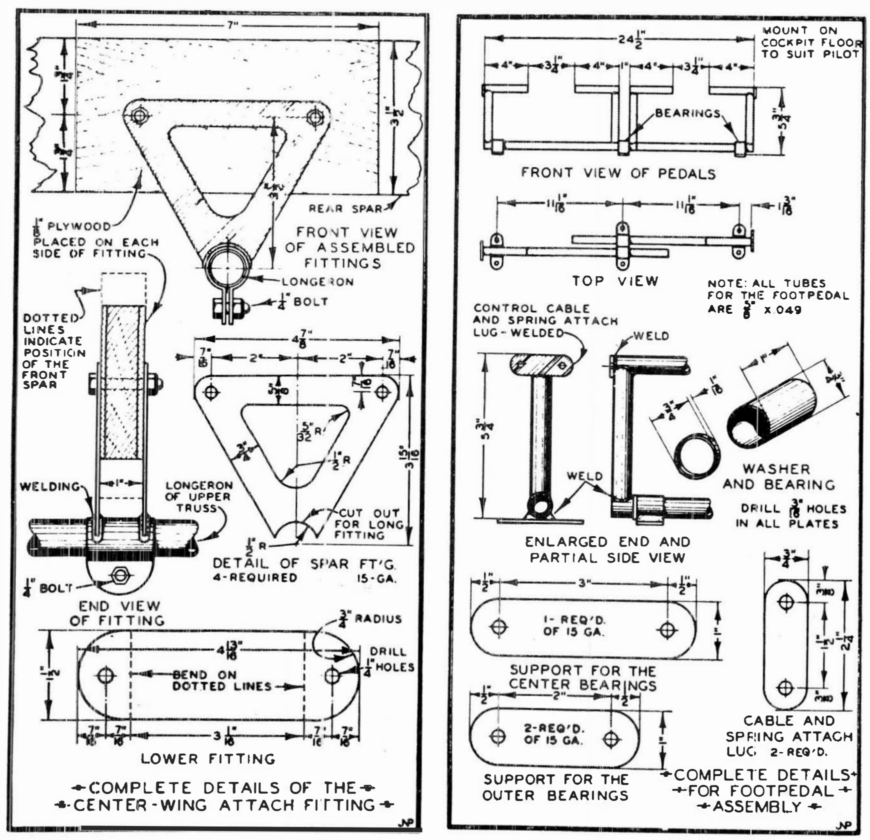
The working drawing on the last page of this article gives such a complete description of the control assembly that further comment is unnecessary. You will note that the pedal assembly is for dual controls, while there is only one stick, which is rigged up in the center of the cockpit. The pilot, therefore, will have the stick at one side instead of between his legs. The gun should be placed on the most convenient side for the one who will usually do the taking off and landing. If dual control is not desired, one set of pedals may be omitted.

Rigging

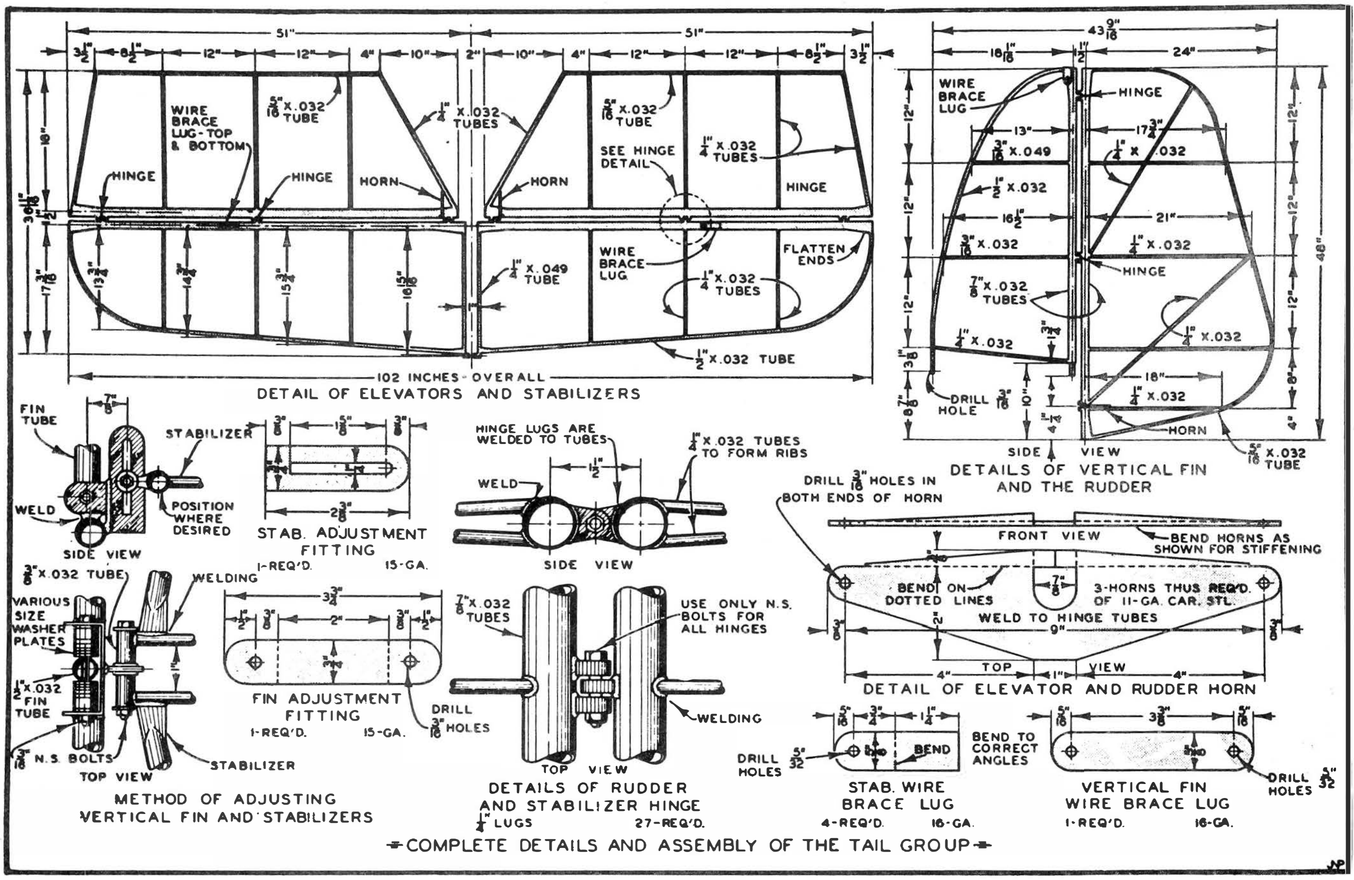
Both wing panels should be set exactly alike. The horizontal stabilizer should be level unless it is found necessary to correct for either nose or tail heaviness. Take

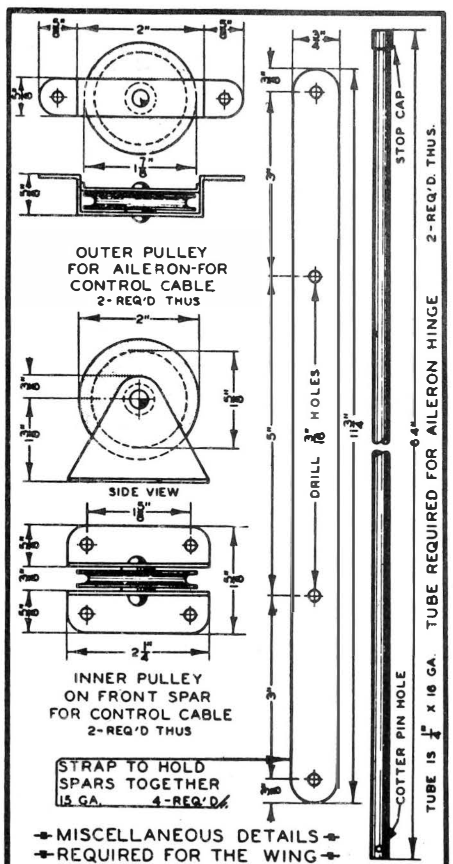


These two working drawings give dimensions and details for attaching the front and rear flying struts to the wing spars. You will note that the spruce spars are protected by placing a piece of 1/8 in. plywood between them and the strut fittings, which are made of 20 ga. steel. The flying struts are attached to the spars between the last two full ribs on each wing. Place these fittings accurately.



These working drawings show the method of attaching the wing to the top longerons, and give full details for the dual control foot pedal assembly. One set of pedals may be omitted if desired.

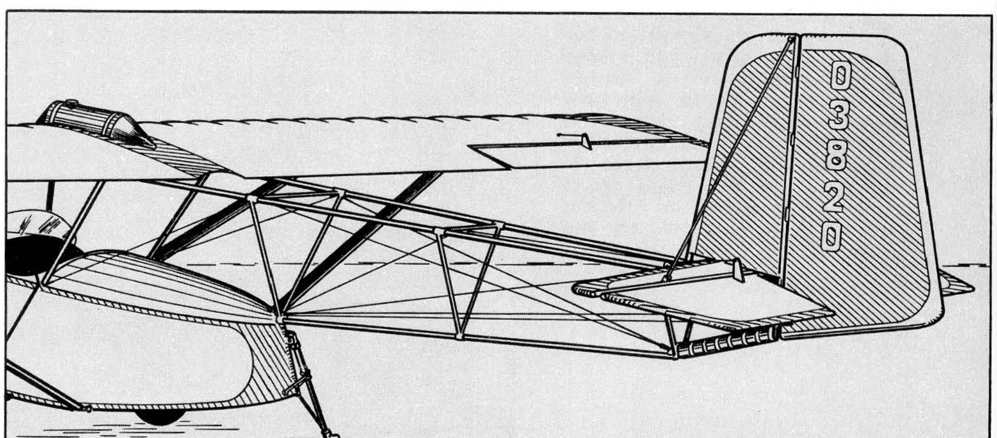




These details are required in the wing construction.

will give you a good idea of the external appearance of the tail surfaces. The working drawing of the tail group will show you everything you will need to know about this part of the job. The entire empennage is welded up of steel tubing, and if you don't forget the extra care which the smaller sized tubing will require in welding you should have no trouble with this work. There is little difference between the horizontal stabilizer assembly and the vertical-fin-rudder assembly save size and position. The stabilizer and rudder both have 7/8 in. by .032 tube hinge beams, while 5/16 in. by .032 and 1/4 in. by .032 steel tubing is used elsewhere, as pointed out in the drawing.

You will find that the empennage will warp considerably where the light tubing is used, but with a little careful checking



A good idea of the general appearance of the tail assembly and outrigger is given by this photo.

To save work it is advisable to assemble the wing on a table to which blocks have been fastened in a straight line so that they will just fit inside the spars. This will enable you to remove the wing from the jig true, if equal pressure has been put on the brace wires.

In assembling the wing, slide the wings on the spars to their approximate place. Then put plywood reinforcements on at the fitting, joints and drill for fitting. The ribs may then be slid to the correct place and nailed and glued firm.

The jig for the wing ribs may be made similar to that of the fuselage, but it is better to lay out the rib full size, from the dimensions given on the working drawing, on a large piece of heavy paper, the paper being fastened to a flat board of sufficient size.

The boundaries and keepers for the cap strips and diagonals should be formed out of rib stock. This rib stock may either be purchased ready cut, or may be made in your own shop by sawing spruce into strips which are a full quarter of an inch square. Have all the rib stock of the same dimensions. Blocks, of the same dimensions as the spars, should be nailed in at their proper places.

When the jig is once made, making the ribs becomes a simple process. The rib stock is cut to proper size and placed in the jig; then the junction points are covered with gusset plates cut from 1/16 in. plywood, glued on with casein glue, and nailed with 1/4 in. by 22 wire nails. When one side of the rib is fastened together, remove it from the jig and glue and nail the gusset plates over the junction points on the other side.

All ribs are alike except those forming the ailerons. To change the jig for your aileron ribs, cut out 1 1/8 in. immediately behind the rear spar. A half inch block, representing the aileron spar, should be then nailed behind this cut-out on your jig, the strut and diagonal pieces at this section of the rib being moved back proportionately. A careful study of the drawings will make this detail evident to you.

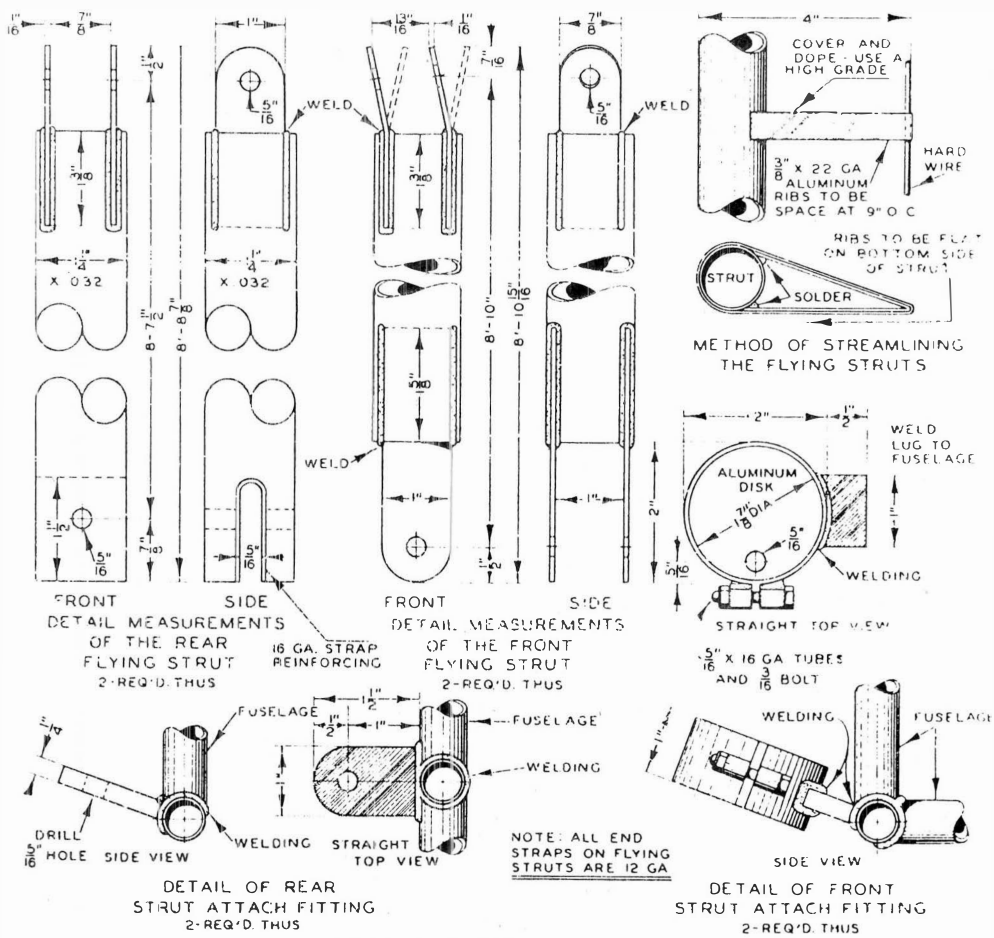
Incidentally, the dimensions of the aileron spar are not shown on the drawings. These spars (one for each wing) are of 1/2 in. spruce stock. The depth of all spars is best ascertained by measuring the openings after your airfoil is laid out.

When assembling your wing, have both end aileron hinges come inside the hinges on the spar. This is necessary to prevent the aileron from traveling sidewise.

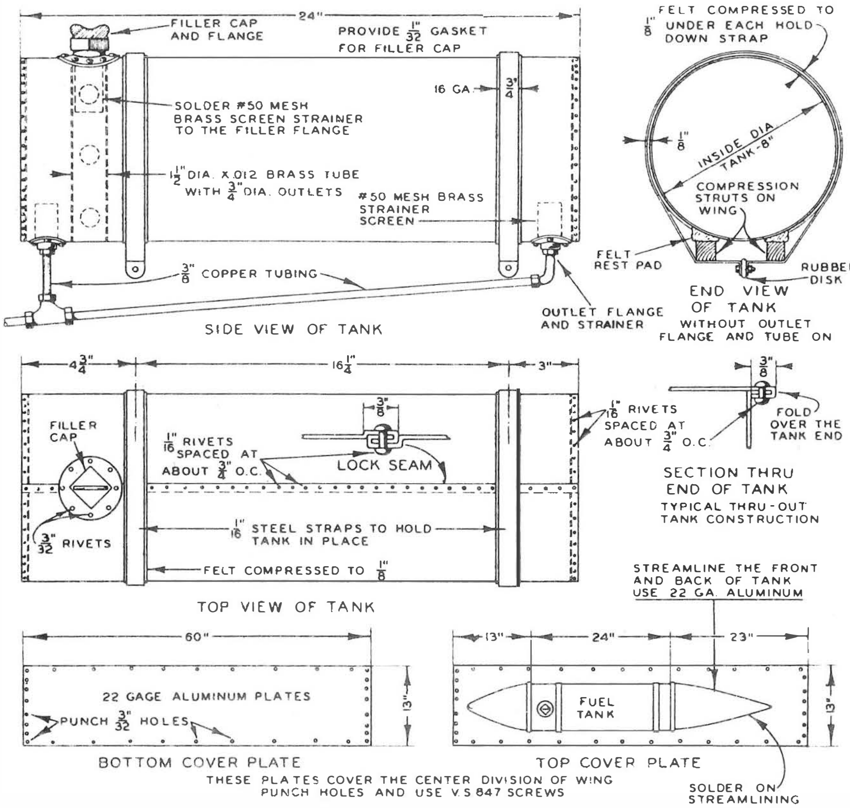
The Empennage

The various photographs of the original ship, especially the one on the last page of this article,

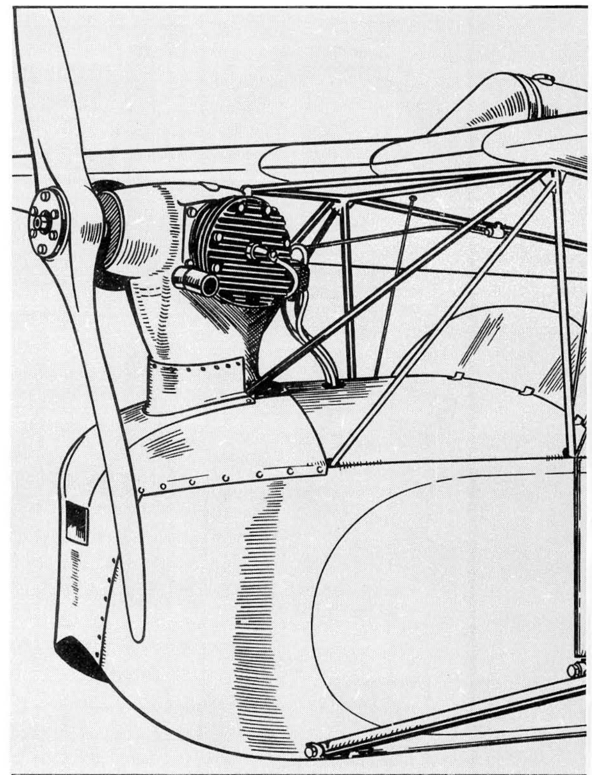
Complete details of the flying struts and attachment fittings are given on this plate. All struts are of 1 1/4 in. by .032 ga. chrome molybdenum steel tubing, streamlined with ribs of 3/8 in. by 22 ga. aluminum soldered to the struts and spaced 9 in. from center to center. These are covered with aircraft fabric and doped. If these struts are constructed accurately you won't have to worry about the angle of attack of the wings, as this has been taken care of on the drawings.



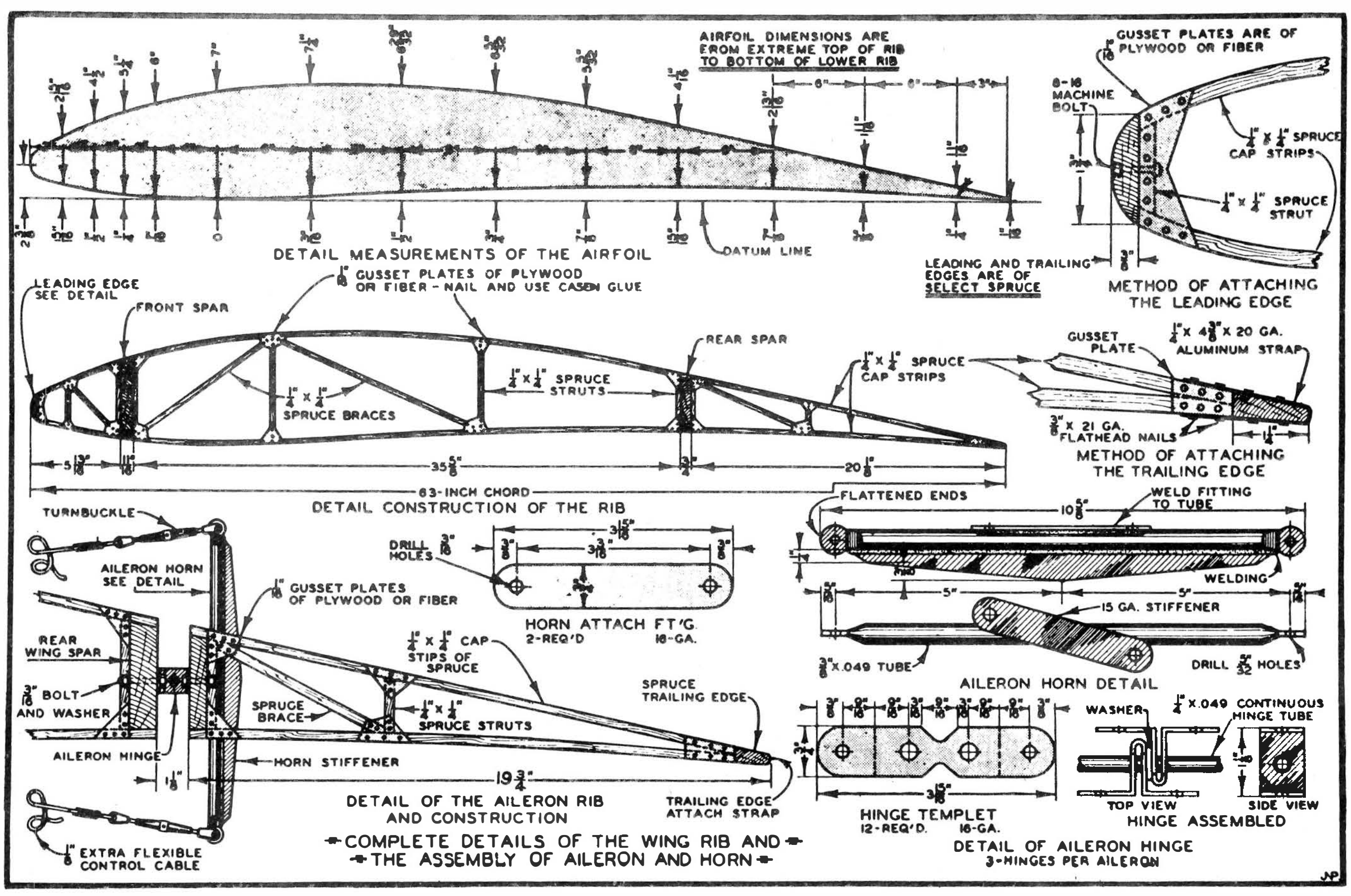
COMPLETE DETAILS OF THE FLYING STRUTS AND ATTACH FITTINGS

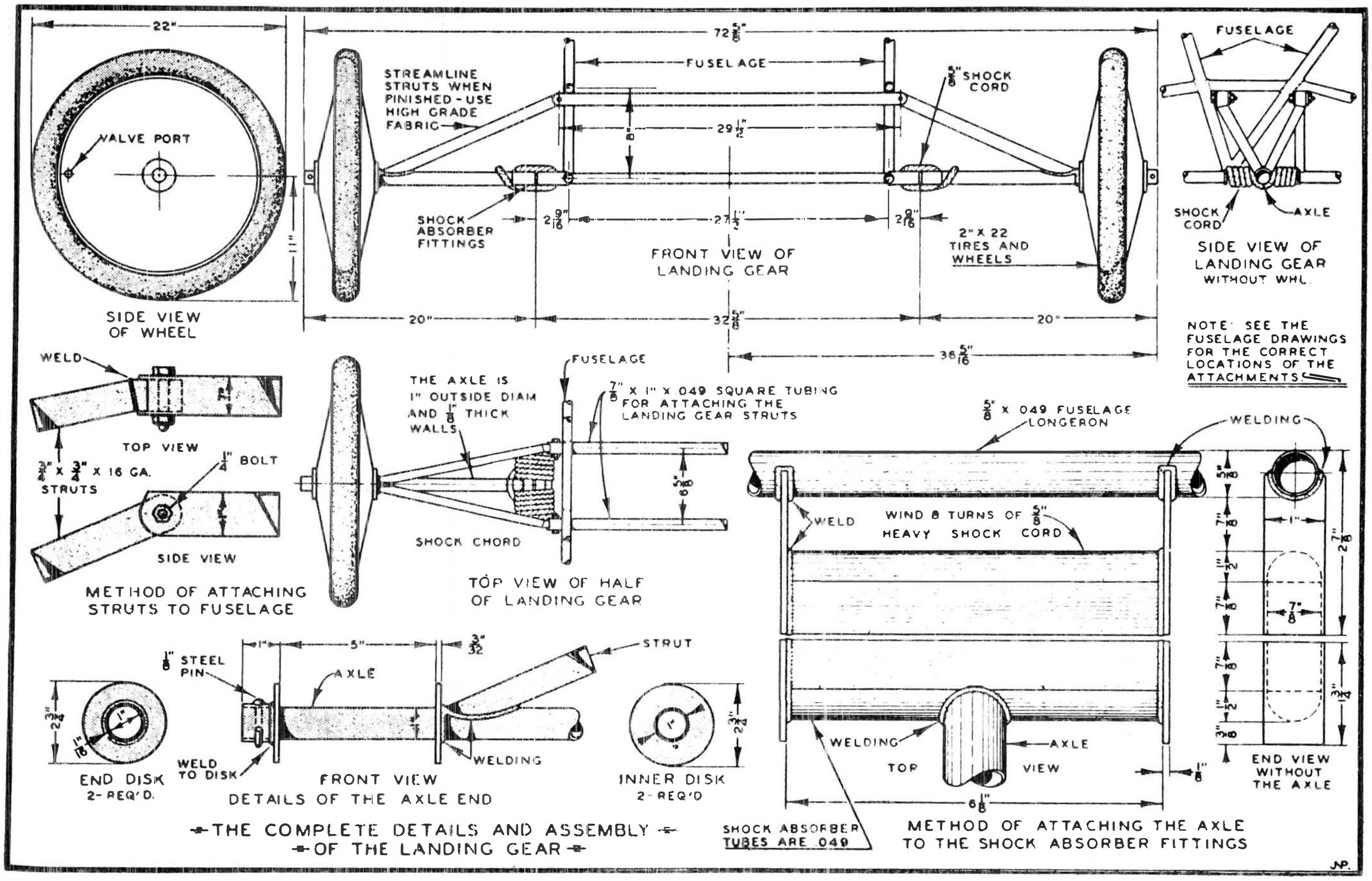


Complete details for the fuel tank and the method of mounting to the wing are given in this working drawing. This tank is made of .012 brass and is covered with felt. This construction calls for expert workmanship. Note that the tank rests on the compression struts in the center section of the wing, and that the wing at this point is covered with aluminum plates.

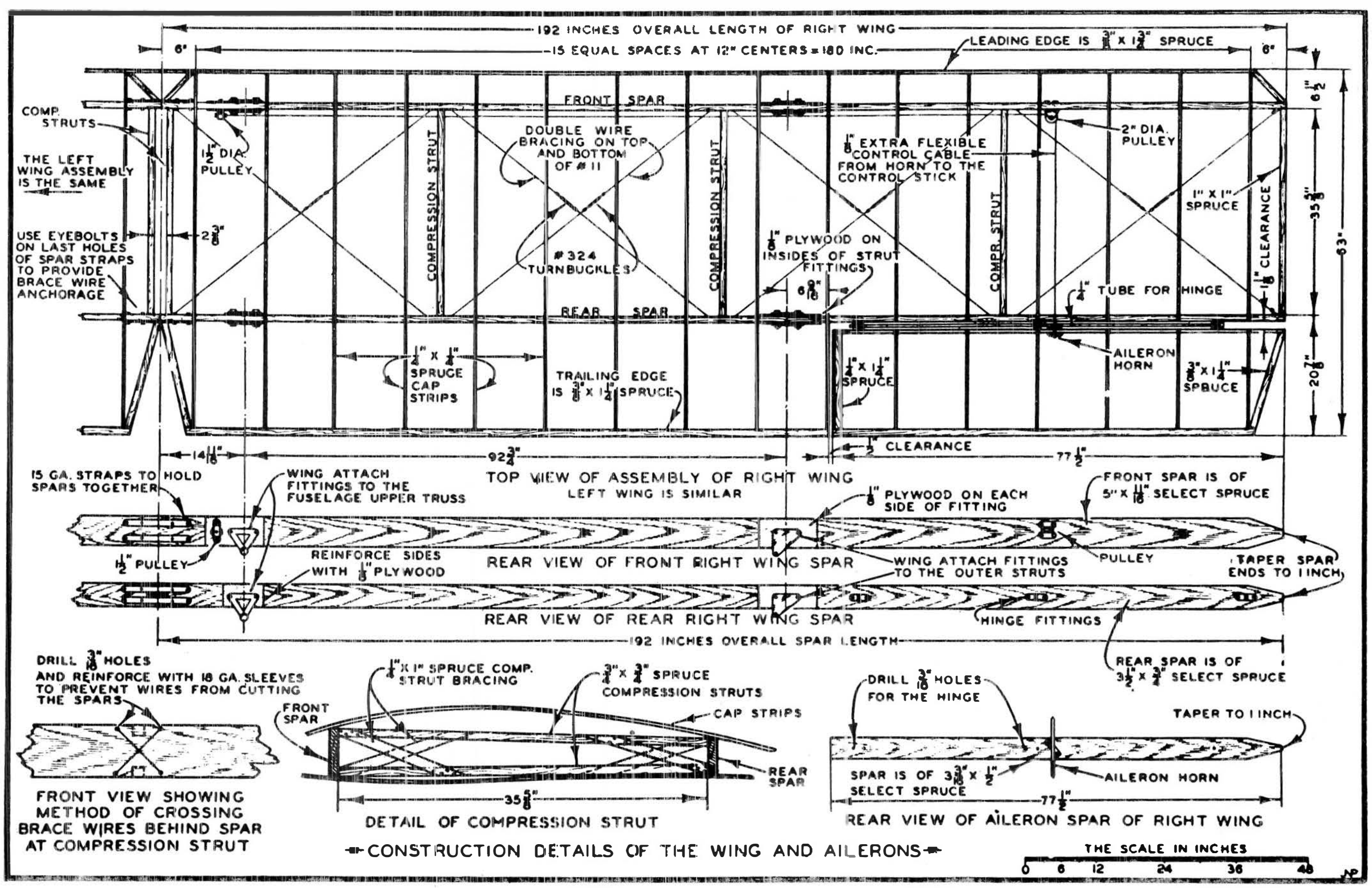


The Aeronca motor can stand lots of work without constant attention, but this very easily accessible mounting makes attention a pleasure.





SIMPLE CONSTRUCTION AND DETAILED PLANS MAKE "BATHTUB" EASY TO BUILD



tion, so if you are able to go ahead with the fuselage, the rest will be easy. If the welding is too much for your workshop, it will pay you to call in an experienced welder. A good man should be able to do the whole job for you in two days; and you will be more confident when you take the air if you know that a workmanlike job of welding has been done.

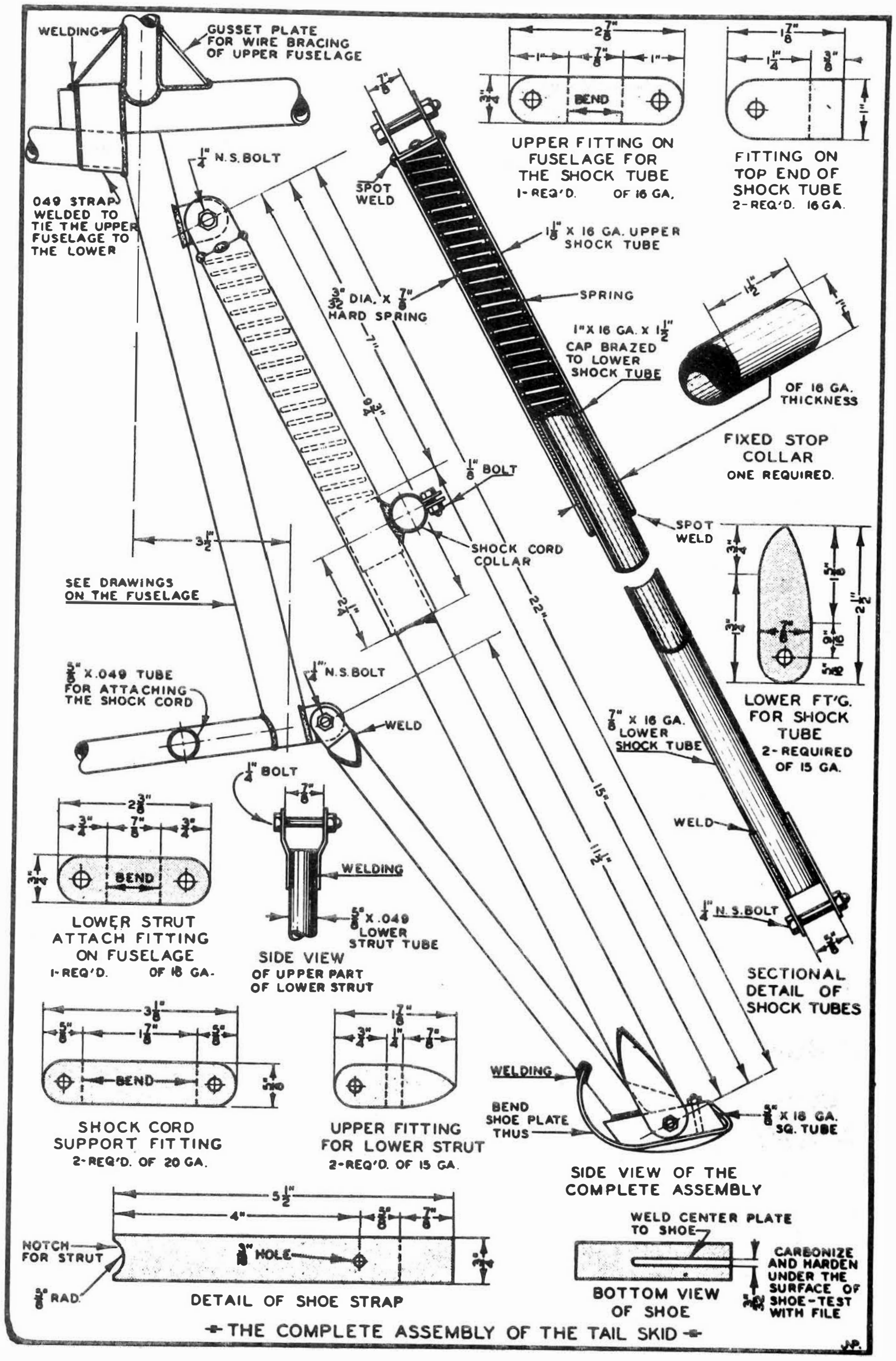
Just a word of warning before you start building. If you haven't the price of an Aeronca motor, or one of the other motors especially designed for lightplanes, such as the Continental A-40 or the Bristol Cherub, build some other plane. Converted auto or motorcycle engines cannot be used.

Building the Wings

The wings are of the conventional spruce and fabric construction, so if you have been able to complete the welded steel fuselage, the rest should be easy.

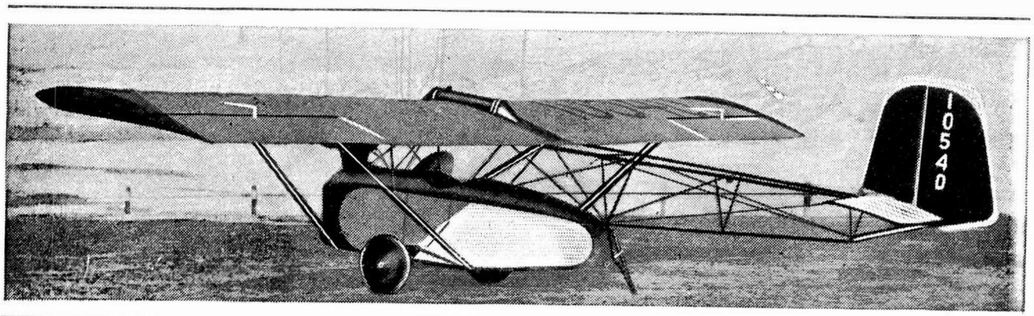
Only select spruce, free from knots and pitch pockets, should be used for the wings. It should have 11 to 12 annular rings to the inch and should be straight grained. There is absolutely no substitute for aircraft spruce in this work, and one is foolish to attempt to cut the cost a few dollars by using cheaper wood. When in the air the weight of yourself, your plane, and your passenger are carried by the wing, and the best material is none too good.

If the wood for spars is procured at your local lumber yard it is advisable to have it cut too wide and then let it season in a moderately warm and shady place, so that in the event of slight warpage it can be cut and made true. Wood secured from an aircraft lumber company is



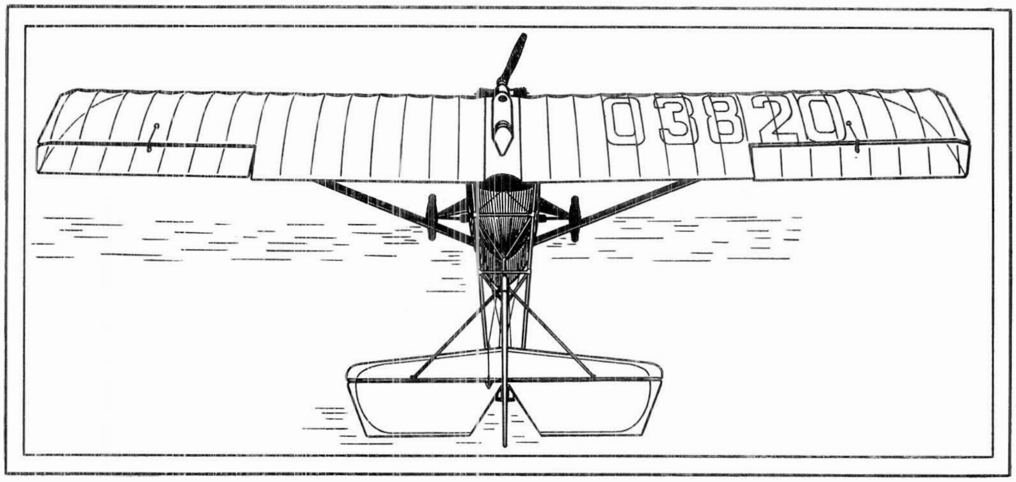
usually thoroughly seasoned before being cut and sold.

The wing is double wire braced with No. 11 half hard wire (market wire). The top and bottom wires pass through the edge of the spars and cross behind the compression struts.



This three-quarter view shows the unique fuselage design from which the "Flying Bathtub" derived its name. The large wing area evident here reveals why this ship can come in and land at 20 mph.

A bird's-eye view of the "Flying Bathtub", with the bird looking it over from the hangar roof.



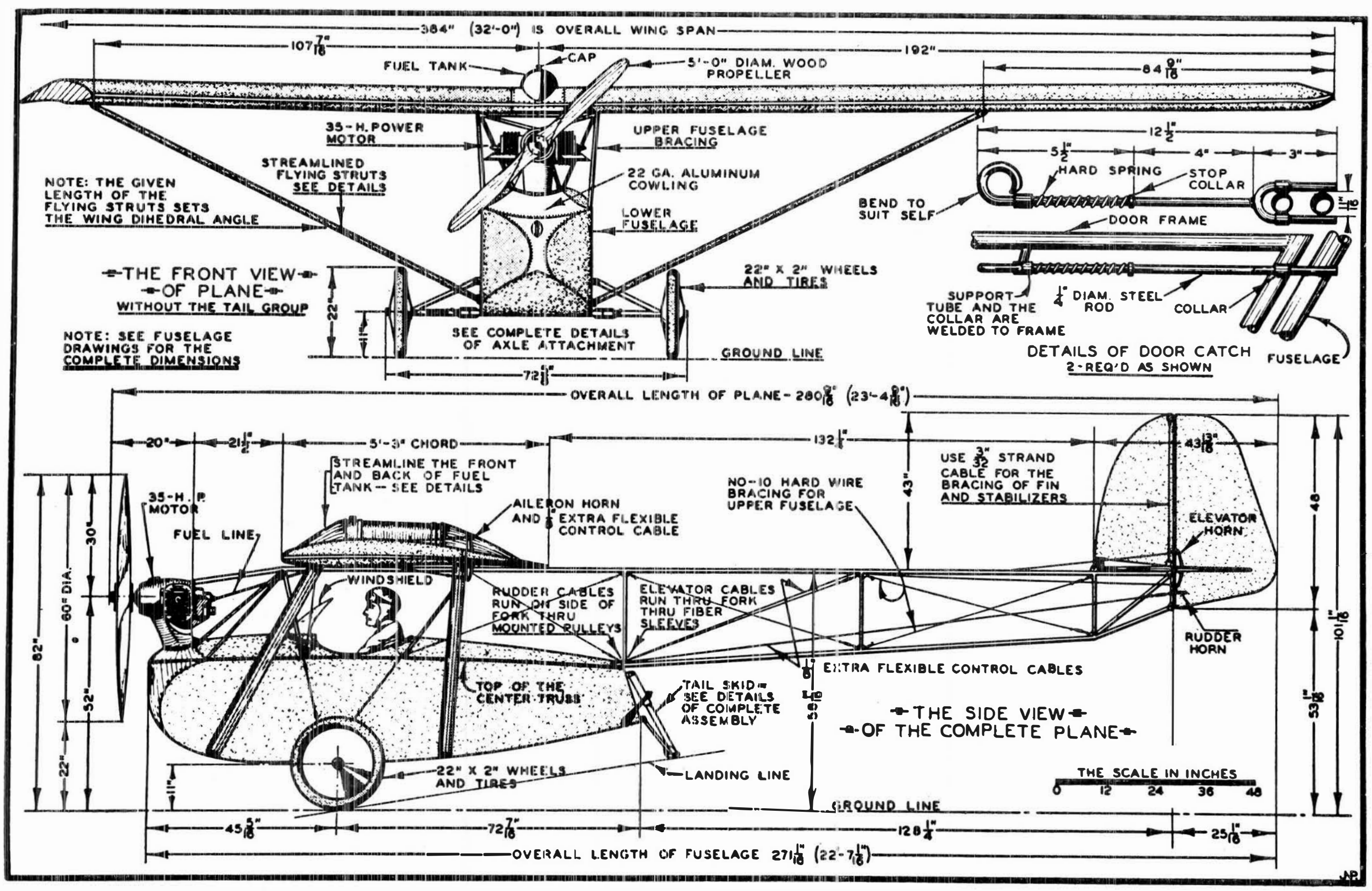
in the same jig. Now connect the two sides with the main cross members, both top and bottom, being sure to have them at the proper joints and both sides the same distances. Square the assembly by measuring opposite diagonal corners and getting both distances the same. Then put in diagonal braces. If proper care is taken the fuselage will be square.

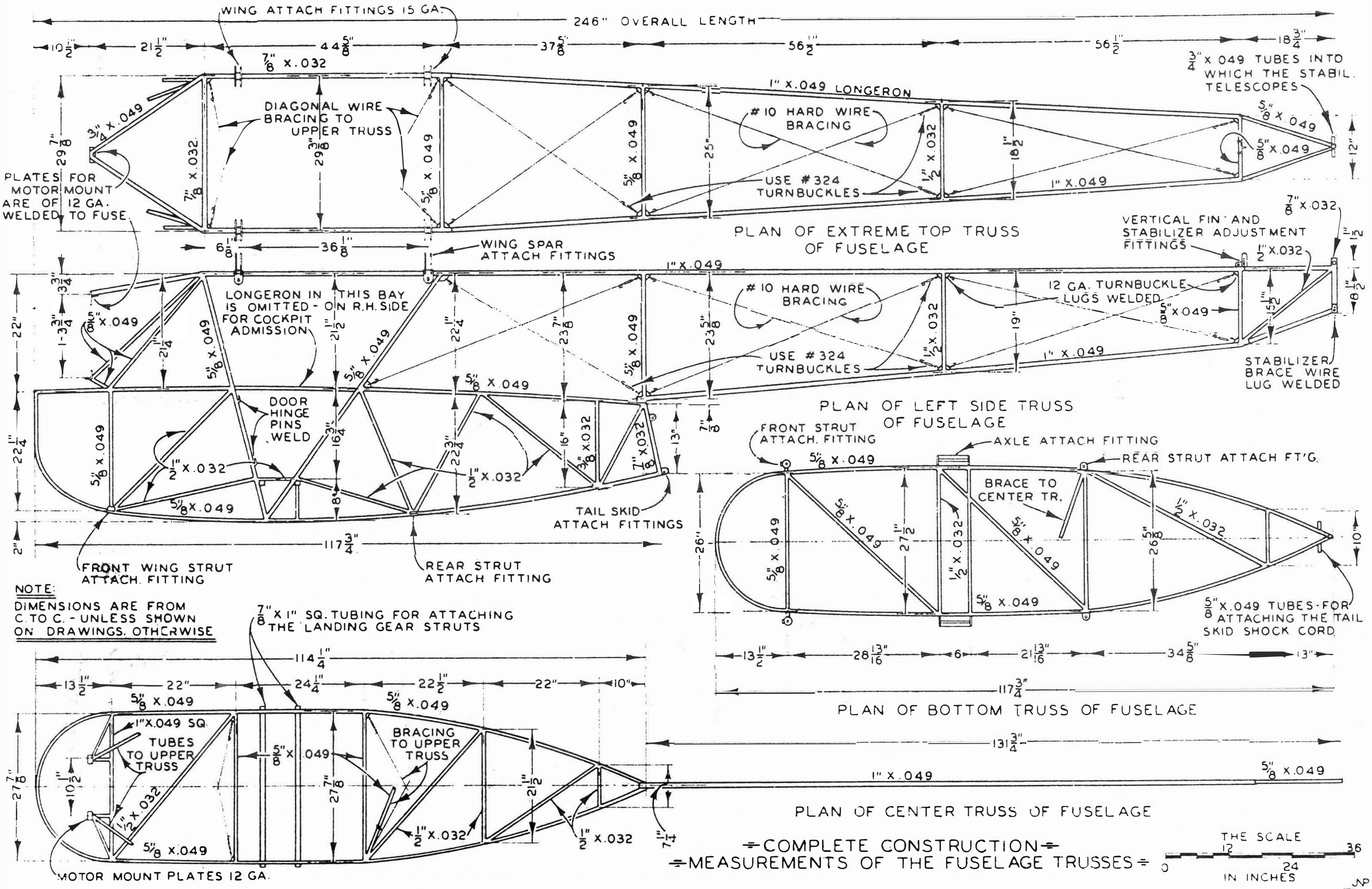
Now fasten the fuselage solidly to the floor and proceed with the outrigger. This should be kept as nearly true as possible, but being wire braced, minor variations are readily corrected. Brace the outrigger with No. 10 hard aircraft wire.

The landing gear is built entirely of 7/8 in. by 1 in. square .049 tubing with the exception of the axles, which are 1 in. with 1/8 in. walls round tubing. This gear is of very simple construction, and the plans are so clear that no one will have any trouble with this detail.

The tail skid, which is shown in minute detail in the drawings, contains a 1 in. by 8 in. coil spring having a pressure capacity of 80 lbs. In constructing, first build up both ends, put the spring in the upper end, compress the strut, put in the bottom bushing, and weld as shown in the plans. The strut should be left compressed until cool so as not to draw the temper from the spring.

In the next installment we will take up the construction of the wings. These are of the conventional spruce and fabric construc-

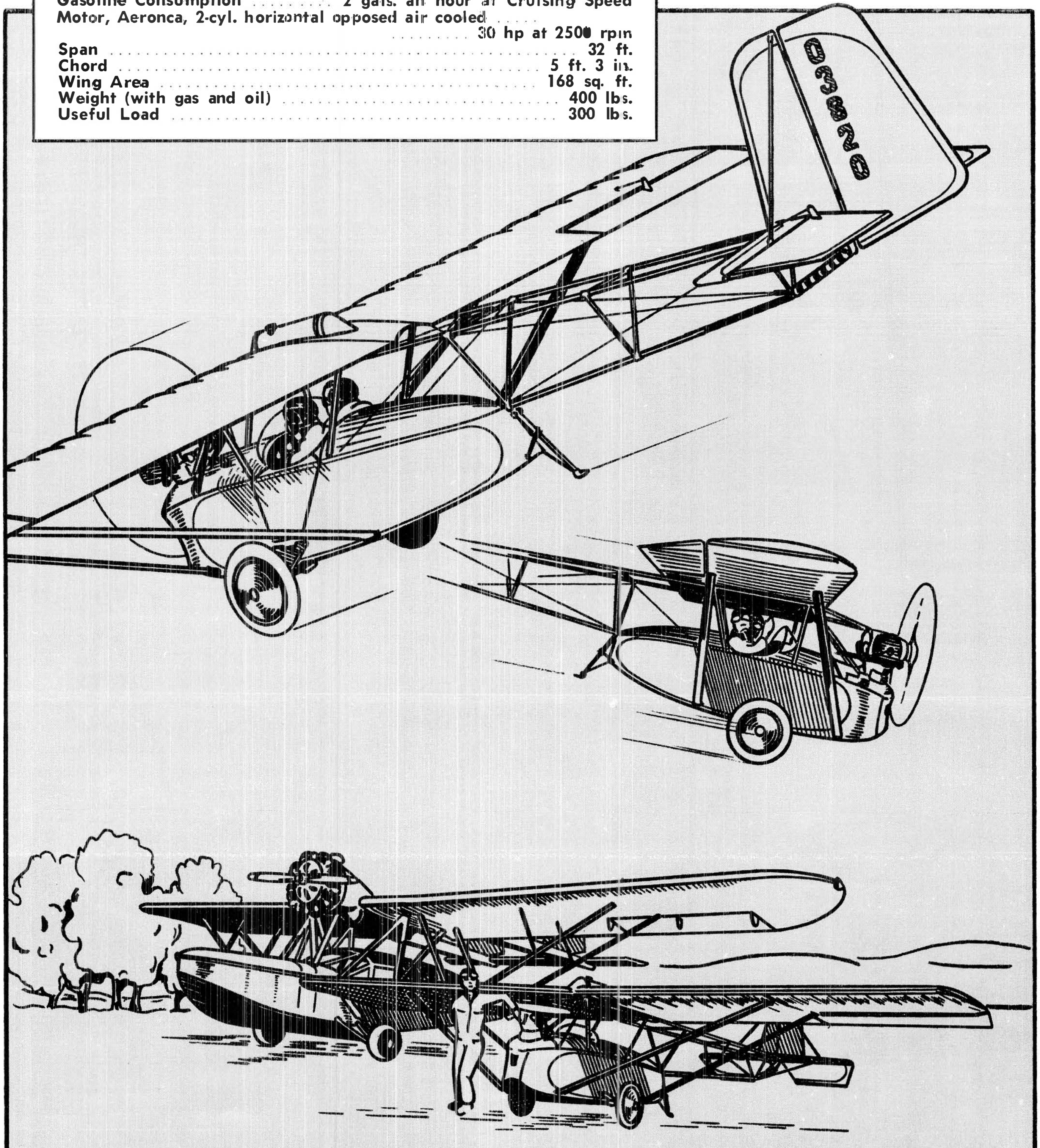




COMPLETE CONSTRUCTION
MEASUREMENTS OF THE FUSELAGE TRUSSES

SPECIFICATIONS OF THE RAMSEY "FLYING BATHTUB"

High Speed	65 to 70 mph
Cruising Speed	60 to 65 mph
Landing Speed	20 to 25 mph
Initial Climb (1 person)	400 fpm
Initial Climb (2 persons)	300 fpm
Gasoline Capacity	5 gals.
Gasoline Consumption	2 gals. an hour at Cruising Speed
Motor, Aeronca, 2-cyl. horizontal opposed air cooled	30 hp at 2500 rpm
Span	32 ft.
Chord	5 ft. 3 in.
Wing Area	168 sq. ft.
Weight (with gas and oil)	400 lbs.
Useful Load	300 lbs.



THE RAMSEY TWO-SEATER LIGHTPLANE LOSES NOTHING IN THIS STRIKING CONTRAST WITH A LARGE PLANE OF SIMILAR GENERAL LINES. SOUND DESIGN AND SAFETY ARE CHARACTERISTIC FEATURES OF THE TWO SHIPS.

Illustrations by Joe Deady

BUILDING THE RAMSEY FLYING BATHTUB

By W. H. Ramsey, Designer

The Ramsey "Flying Bathtub" is a lightly powered ship which has been designed with the sensible intention of creating a moderately fast trainer which can also be used for cross-country work where the owner's pleasure rather than speed is the primary consideration. Inexpensive to build, simple in its general design and structural details, it has certain definite characteristics which will appeal to one who appreciates real performance.

Perhaps the outstanding single characteristic of the "Bathtub" is the way it handles in the air. Test flown by one of the best known Northwest pilots, it proved to be easy to take off, simple to handle in the air, and a positive joy to land. Veteran pilots who have since flown this job agree that in spite of its moderate horsepower and general light weight, the bathtub behaves and flies exactly like a large and powerful ship.

This is of the utmost significance to amateurs, who are apt to find in the average lightplane a tricky behavior which calls for more experience than they are likely to have. The pilot who test flew this job has remarked that it is safe and easy to fly; that it will land itself, and that it has no apparent vices.

Even a beginner can pull the "Bathtub" off the ground with a run of 100 feet or less. (By beginner I mean a student pilot and NOT any person with no training at all). Once in the air, its extreme ease of handling, remarkable stability and responsiveness to controls make it an ideal ship for sport purposes. With the unusually low landing speed of 20 mph, many of the difficulties presented by this operation are automatically eliminated. The nature of the design permits exceptional vision, and while this feature is important at any time, it becomes paramount in landing.

The "Flying Bathtub" is definitely not in the "Flying Post Card" class, but with the Aeronca motor may be said to have the performance and other qualities usually found in larger ships. Although its performance is best when used as a single-seater, it carries a passenger with little loss in efficiency. Its low weight makes it possible for one person to move it into and out of the hangar with ease, and the simple little motor is not only extremely accessible, but also sufficiently rugged to stand lots of work without constant attention.

Fuselage and Outrigger

The fuselage, tail surfaces and landing gear are built of chrome-molybdenum seamless steel tubing of conventional braced type. The wing is of wood and fabric construction. All plate type fittings are made from .049 chrome-molybdenum steel, and only aircraft steel bolts are advisable.

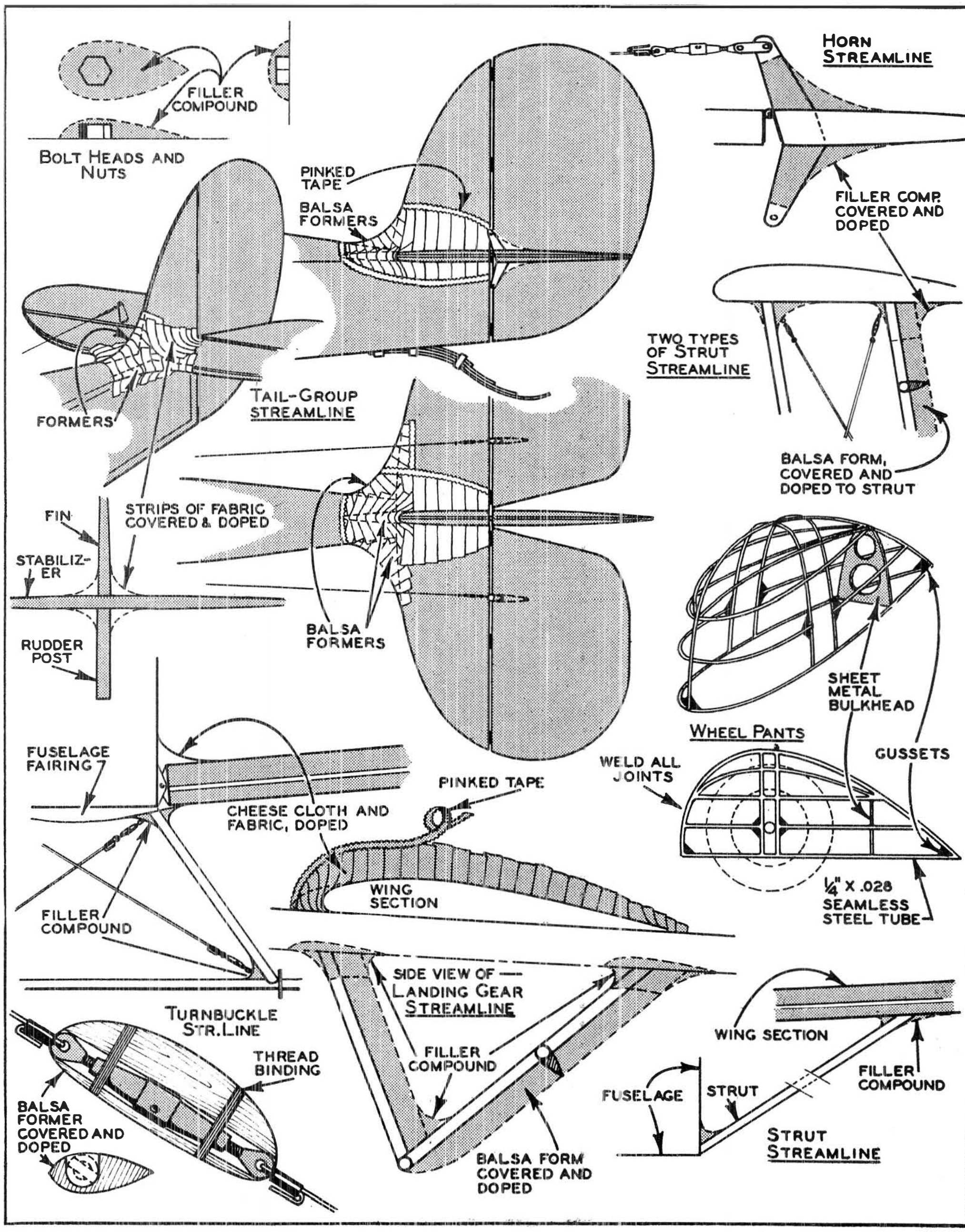
In starting to build the fuselage it is necessary to procure a flat surface, preferably a table, large enough to lay out all the measurements. All measurements, unless otherwise specified, are from center to center of the tubing. Care should be taken to have these absolutely accurate.

After laying out the outline from the centers, make allowance for one-half the tube's diameter, and drive, straight in, 10-penny nails between which the tubing will be placed and held true until spotted together with a welding torch.

Care must be taken in welding chrome-molybdenum tubing, as insufficient heat will make a very nice looking weld, but upon destroying the weld, it will be found that the filler is only pasted on. Too much heat will destroy the metal and weaken the joint.

Having the jig ready for laying in the tubing, curve the members to be used for longerons as nearly to shape as possible to form the top and bottom lines of the fuselage. By curving the tubing, which can easily be done cold (do not heat), there will be no sharp bends at the joints and the work will be symmetrical. Place the longerons in the jig, then cut and lay in all brace members. Then spot weld and remove the assembly. Cutting off the nail heads will assist in removing the work.

As both sides of the fuselage are identical, both may be built



This drawing shows clearly the method of airplane streamlining described in this article, in which sawdust mixed with thick dope is used, patted into streamline shape around the joint to be faired, covered with fabric and then doped and lacquered. By following the methods described, you can increase the speed of your plane from 25 percent to 30 percent over its present speed. If you plan on entering your ship in any air races, streamlining is absolutely essential if you're to make a good showing.

go in for racing. A job that is different and bright makes a ship look as if it could do things out of the ordinary. Do not, however, get a can of a dozen different colors and make your ship look like a color chart. Two or three harmonious colors, applied in neat design to your ship, will make it look like a million dollars.

What benefits can you expect from streamlining your ship? As an example, take a Moth which was streamlined exactly along the lines told here. Before streamlining, she could do 93 top speed, land around 35, and take off at 35 in 8 seconds. All this with full load. After streamlining, she did 130 top speed, landed at 45, and took off at 35 in six seconds, which is a worthwhile increase, as anybody will agree. Usually the streamlining job will help your ship fly 25 percent to 30 percent faster. Of course, the landing speed will also be increased, but that is inevitable with a fast ship and cannot be avoided.

As a final word, be sure that the parts you are going to streamline are in correct rig, for nothing is more annoying than to be forced to wreck a good job to get at some pesky turnbuckle or strut joint that needs adjustment. • • •

Streamline Your Lightplane for Greater Speed

by F. E. Nagle

Let us suppose that you have a lightplane which will hit around 80 mph full throttle. How would you like to have this same ship make the same speed at three-quarters throttle? There's no magic about it — it's simply a question of streamlining, which can be done easily and cheaply.

To begin with, don't streamline your ship unless its assembly is permanent. If you have to take off the wings and haul the ship home after every flight, don't streamline the parts that are removed. For streamlining materials, you will need some thick dope — real thick stuff, just like fish glue — some scrim or cheesecloth, pine sawdust, some regular airplane fabric, also some regular dope and lacquer or paint. The total cost of these materials for a plane in the Pietenpol Air Camper class is around $12.00.

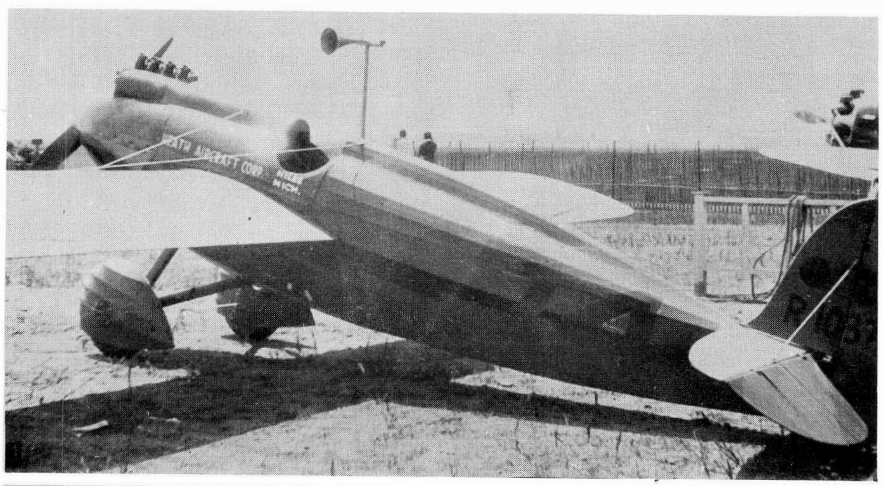
Now for the actual job. If you think it's a tough one, dismiss your fears — anyone who can pat some sawdust around a piece of tubing can do a good job. Mix sawdust with some of your thick dope until the mixture feels like raw hamburger. Coat the part you are streamlining with some thick dope and let it stand a few minutes. Then apply the sawdust mixture around the part and pat it into streamline shape. Now get your scissors and cut a piece of cheesecloth to fit around the job, and dope it well into the sawdust part. Let this dry, and later on dope it until it is smooth. After the dope has dried the joint can be lacquered or painted.

If your ship is a big plane or a low-wing job, the wing can be streamlined into the fuselage quite easily. For this job you will need some thick cheesecloth and several strips of muslin about 2 in. wide. The cheesecloth is cut to fit and doped on the edges to the fuselage and wing so that it assumes a good streamline form. Then dope on the muslin strips so the cheesecloth will assume a curved shape. After this has been fixed to your satisfaction, cut out some airplane fabric and cover the whole thing.

This method can also be applied to the streamline of the fin and the stabilizer into the fuselage. Follow the same methods as on the wing, except that you may have to use formers of balsa or pine at the leading edge to get the proper curve. It's a good idea also to streamline the horns into the control surfaces, and all the tail braces, wires, turnbuckles, etc., on the rear of the ship in the slipstream.

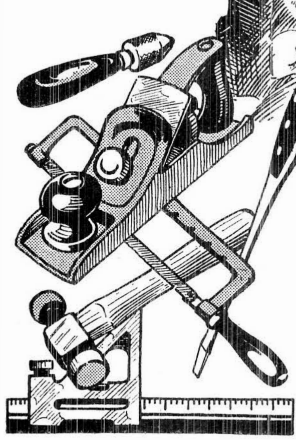
And don't forget your landing gear. Study the drawing on the opposite page and you'll see how simple the job is, although it takes time to do it up properly. Make plain fabric streamlines if your landing gear struts have much play, for the sawdust mixture will crack if used where the parts move a lot. Wheel pants will be easy for you if you build them of steel tubing, as shown. If you've had experience, you can hammer the pants out of sheet metal, but don't try it if it's your first attempt. Pants help considerably in cutting down parasite resistance and getting every ounce of speed out of your ship.

A good color job will go a long way toward making your plane popular with the crowds, if you



The mid-wing Heath "Cannon Ball" offers a good example of streamlining. Note wheel pants made from steel tubing and covered with fabric.

Here we have an inside view of the ideal workshop, with an anxious airplane pilot waiting in the doorway to get a fuselage welded and a tail surface doped. Eighty dollars or thereabouts will get you a woodworking unit and set of tools that will make every amateur airplane builder who visits your shop green-eyed with envy.



cellence. The torches are light, and easily valved for either acety or oxy. And they are light — hung just like a golf club with the right balance and feel, and with a variety of tips, so that you can hardly puddle up the work and make a botch of it. These torches with a complete set of tips come higher than any other single item of equipment, and strange as it may seem, cost only $35.00.

The tanks I have had the artist show are oxy and acety and are rented. A full tank costs about five bucks, will last for a couple of ships, and there is no charge for the tank.

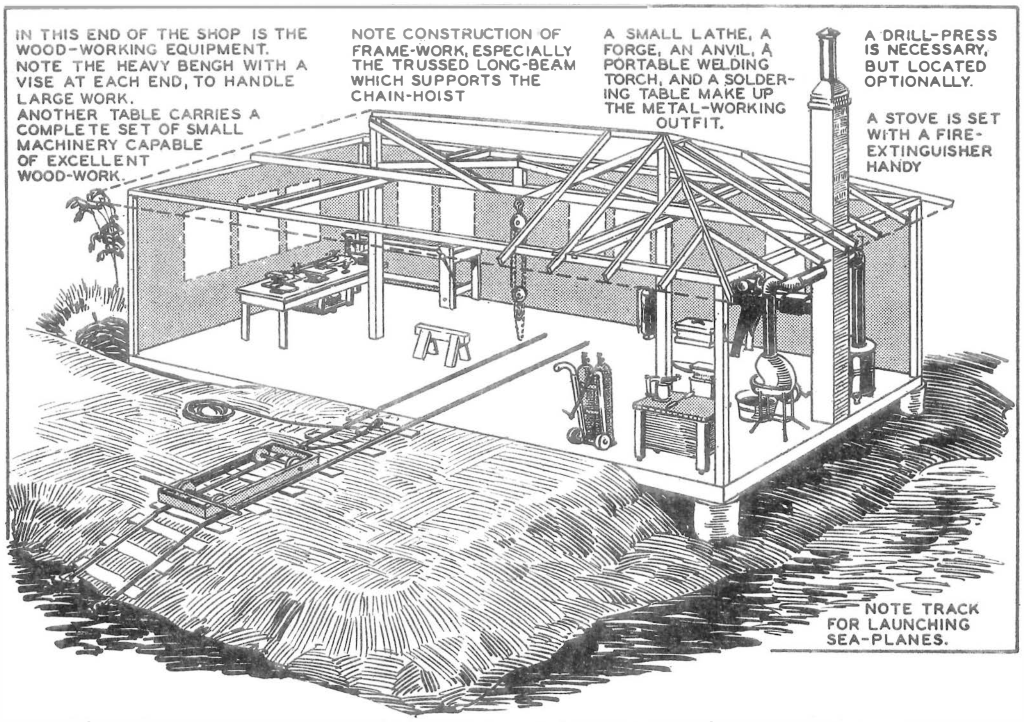
The lathe can be economically purchased from any machinery dealer. It doesn't matter if the lathe is second hand. Lathes aren't like shoes. They're like diamonds. They can always be refaced and they'll turn out sparkling work for many years after they have been given up by some ham machinist as nix cum rous. Refurbishing a lathe is one of the most fascinating things I know of. Hand scraping the bed with an old file, truing up the faces and the bearings, and finding that she is as precise as a hair after it all is one of the rich rewards of shop work.

Now there you are. What could be sweeter? I venture to say that this shop, built with an eye to economy, could be done for $500.00.

But how to get it? you say, frantic like.

Listen: The house will build itself if you'll furnish the boards and the nails and the elbow grease. Get the idea? And then if you turn out parts for this friend and that, and take a nominal charge for your labor, before you know it work is piling up, collections are needing attention, and I bet that even though you can afford it you'll not "have time" for putting in that concrete floor this year yet. Let the world know that you are good at doing airplane repair work, assiduously go after a mechanic's license, and before long you'll learn by doing, and you can't keep airplane repairs away from your doors. Where you go from there depends upon your own head work.

That's the outline of a dream. But it is a good one to go after.



This ghost view of Farmer's "Experimental Paradise" shows an ideal layout of the tools needed by any well equipped shop which is to be independent of outside help and outside fabrication of parts. Welding, machining and woodworking are neatly laid out as departments.

I leave you to guess.

These Knights of the Doped Wing are shown using one of these little woodworking plants during the construction of a lightplane which has yet to be flown. Stub is grinding down rib stock on the sanding face of the lathe shown in the line drawing below the photo. It is a simple thing, yet very strong. I believe the parts total about $4.00 when you get them all corralled.

Gene is ripping out a hole in his shirt with the little saw table. This tool can be bought a bit at a time too. First the saw, for fifty cents, then the arbor for a dollar, then the table for another buck fifty, and before four dollars has whiffled off you have what many mill owners pay $400.00 to get: a saw that will do all the work needed around a light airplane factory. Rip up to 2 in., and dado, too.

Orville is shown tacking down a wing rib so it won't blow away while he lights his cigar before he goes to the phone. Bill and Andy are using the jig saw and the grinding head, respectively. I thought I'd show what a complete line of inexpensive tools can be had, and to suggest some of the good times we'll have when good fellows gather 'round the hot stove league to mull over this feature and that of airy plane construction. If I had a shop like this I'd throw it open on Christmas Eve only, and then I'd charge admission. That's how welcome the general public would be, but for all Knights of the Doped Wing the latchstring would always be out. You might show up just in time to help me move that set of driver tools over into the southwest end of the shop (see said ghost drawing) where good light will always stream in and where most of our woodworking will take place.

That hoist that hangs in the middle is a mail order house's very best $9.00 hoist. In need it can be hooked with a sheepshank knot to the carriage and impressed to haul out of the water ornery bits of cast iron which refuse to come uphill otherwise.

So far we've got us a shop, a swell location, and the woodworking tool end of things accounted for. I should say that the shop, exclusive of ground would cost $250.00, the tools mentioned another $80.00 as a grand total, and the chain hoist at $9.00 makes a grand total of $339.00, which you'll admit is a swell bargain for any idea so hot as this one.

But of course there is the metal working end of things. An airplane factory on one end must be as well equipped as a high grade boat shop, and at the other must be equipped as well as a motor manufacturing plant, with the exception of a foundry. If we could ever get to that we'd be in aitch eee double Heaven. But for a starter, and for a complete start, we'll have a lathe, and a welding set and a drill press. This will do the trick nicely. A forge of course is essential, but these can be bought for a tenspot most anywhere.

The welding table will be slablined like a mortician's table so that all the heat we want to impress on a hunk of tubing will not persist in setting things afire. What the slab will come to depends upon how well you can move in a graveyard after dark.

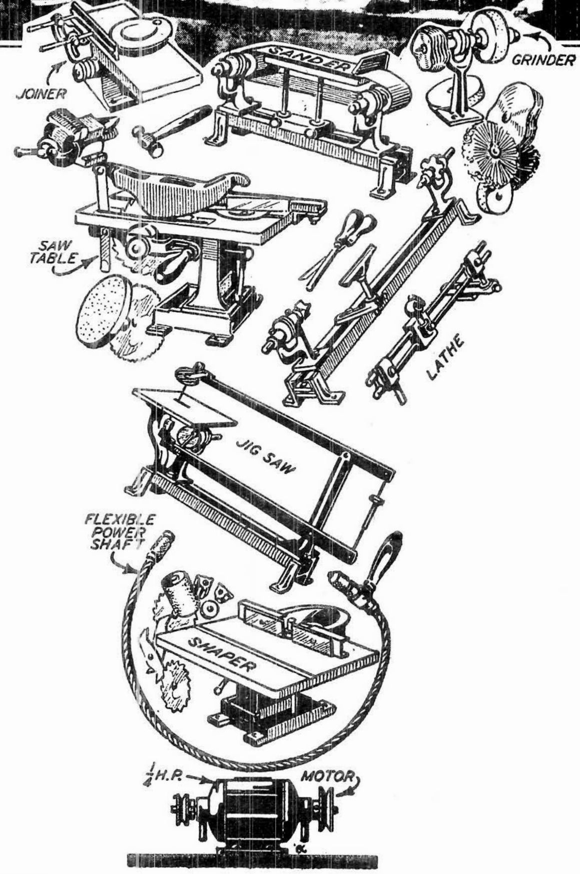
Use nothing but the Smith welding equipment. It is par ex-

the fabrication of light airplanes, light flying boats, water gliders, small motor boats, yea — anything that the hands of mortal man can build.

This edifice will be frame because, with an eye to economy coupled with adequacy, it is the cheapest. The dimensions will be roughly 20 by 24 ft. The house will have a hipped roof, and this roof will be shingled with synthetic mulehide as a tribute to the mechanical age. Use shingles if you feel like it, but my Experimental Station will be covered with roofin' paper. I'm not rich.

The pictures put across better than any description just what the building is expected to look like. Bear in mind she'll have sliding doors, and a concrete floor, because you can weld to your heart's content without setting the works aflame, and that she'll have sturdy joists for hoists to handle airplanes with. I'll bank up the beach, digging the water deeper just off the apron and piling the beach up so that I can lay sod out over the works, so that the sod runs down to the water's edge just as though it were the lawn of some millionaire's plaza running down to the sidewalk. This will eliminate sand, and its deleterious effects upon the equipment and dispositions of those running off the monkey business inside. Nice water front lawn to loll on, and puff a cigarette or two during a cool, shady noon.

The little marine railway with its carriages arranged for either boats or floats, will be made out of 35 or 40 lb. rail and located on ties sunk flush with the lawn. Then the lawnmower in the hands of Andy, the Greasemonk, will be able to do a good job of grass cutting, and no alibis. I'm a stickler for neatness. And, of course, I'll have to have one of these anonymous letter peeper's around as the Shop Spokesman, just like Andy runs the Mailbox on old Double M. No shop is complete without one of these inventions.



Siding of most any sort will build the house, studding of 2 by 4 is easy to get. And concrete is worth what you make it. If you furnish the elbow grease and the sand and water, the cement itself shouldn't cost over five bucks. That's cheap enough for any floor.

The ghost view shows just how the piers (oil barrels) for the floors will be sunk, and just how the apron and the marine railway will look.

But within the edifice! There we'll find sanctuary for those of the likes of us who express ourselves in the things we make.

Tools!

Take a look at 'em. For a beginning I'm putting in a complete set of tools. You know the kind you get from advertisers in *Modern Mechanics and Inventions* magazine — you buy 'em a part at a time, and before you've missed any money you've got a complete workshop. Look at the layout on page ???. Up top, reading right to left, is Gene Shank then Stub Crissinger, parachutist extraordinary, then Orville Hickman, and — sh! is it Andy among the remaining two?

Building Your Own Hangar Workshop

Here is the author's conception of the right kind of place for the amateur to experiment in while dabbling in lightplane construction. It contains hoists, water railway for launching seaplanes, and a good field in the background for land flying. Truly an airplane builder's paradise.

by Weston Farmer

The weary eye of the reader may fall upon these pictures of my ideal workshop and accuse me of another brain wave, or of dreaming of something so very far removed from the kin of reality that it'll never be brought to earth. But glance at the layout, the tools, the ghost picture, the whole set up — and then brighten your optics when I say any fellow of average ability can throw himself together just such a shop at a cost which can be reclaimed very nicely from the work such a shop is capable of.

How to finance it, you ask? I know you can't use shoe buttons for money. But listen a bit and I'll sketch the elements of the picture. Then we'll return and fill in the details.

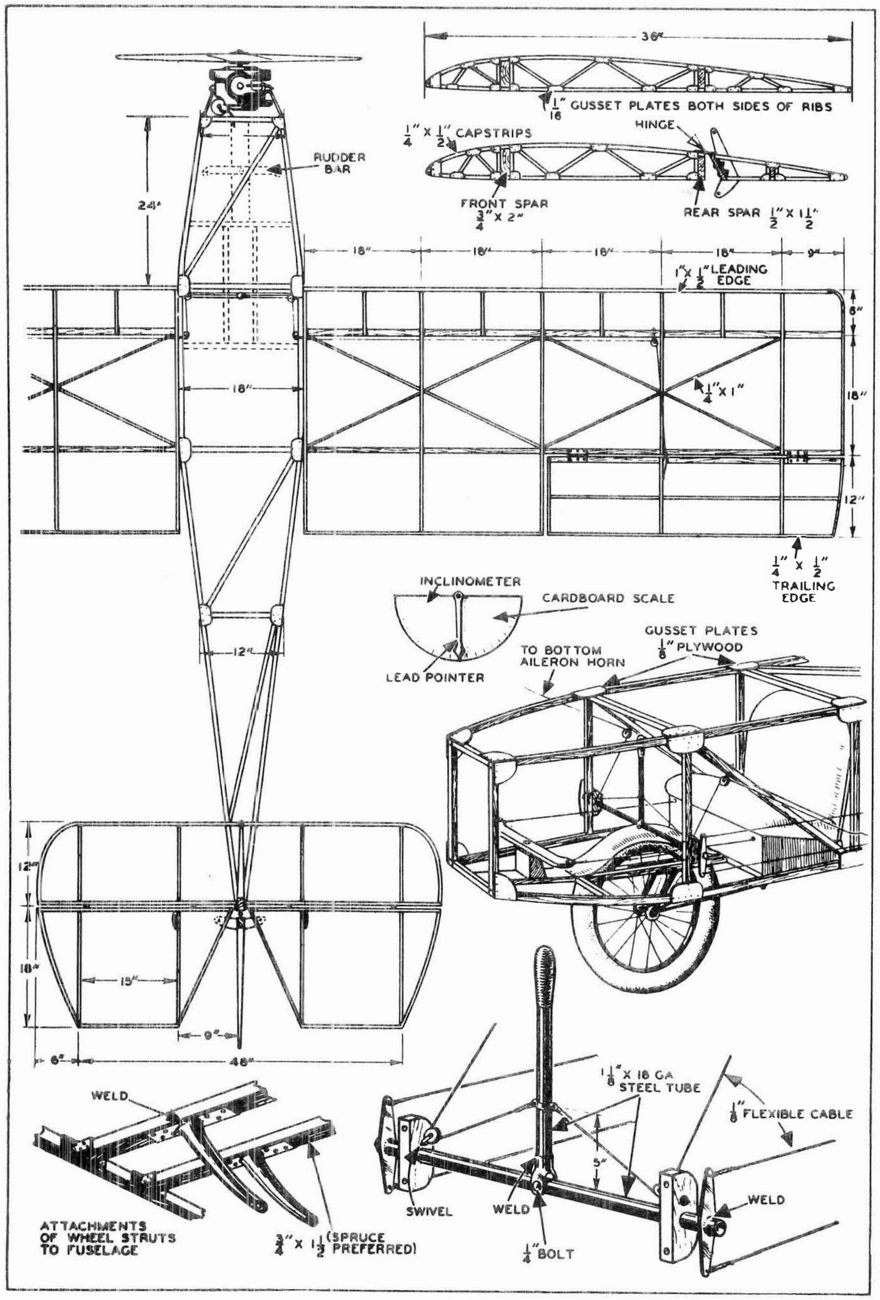
I know a place where there is a sandy-bottomed lake which is a mile or so across. This sand bottom is clear and hard. The lake is big enough for anything up to a Fairchild to get in or out of, and of course for that light, single-seater ABC simple seaplane nobody has yet given us, the lake will be comparatively like an ocean. Given: one (1) good lake. That's the first essential in this Experimenter's Paradise I'm painting.

On this lake, which is like hundreds of others, is a good beach and a little rise which is well wooded. Back of the grove is a good flat 40 acre field, practically square. A great place for any kind of ship to "flugzeug", from as der Deutschers say. That's essential No. 2: a good man's-sized flying field.

And right betwixt and between the lake and the field goes the edifice surrounding the collection of tools I propose shall be gathered from all sources for

Airplanes are very fine things for the grown-ups, but boys who want to fly are barred from this thrilling sport. This little aero-cycle will give you the feel of flying without leaving the ground.

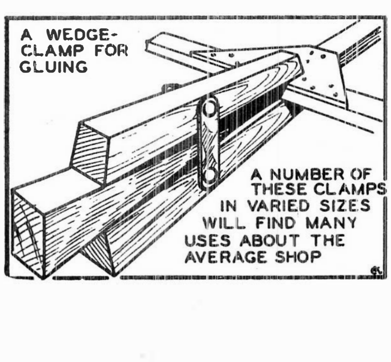
The simple working drawings on these pages tell how to proceed in constructing "Penguin", so-called because it has wings but cannot fly. As ship does not leave ground, it does not require as good workmanship as a real plane, but a good, sturdy undercarriage is needed.



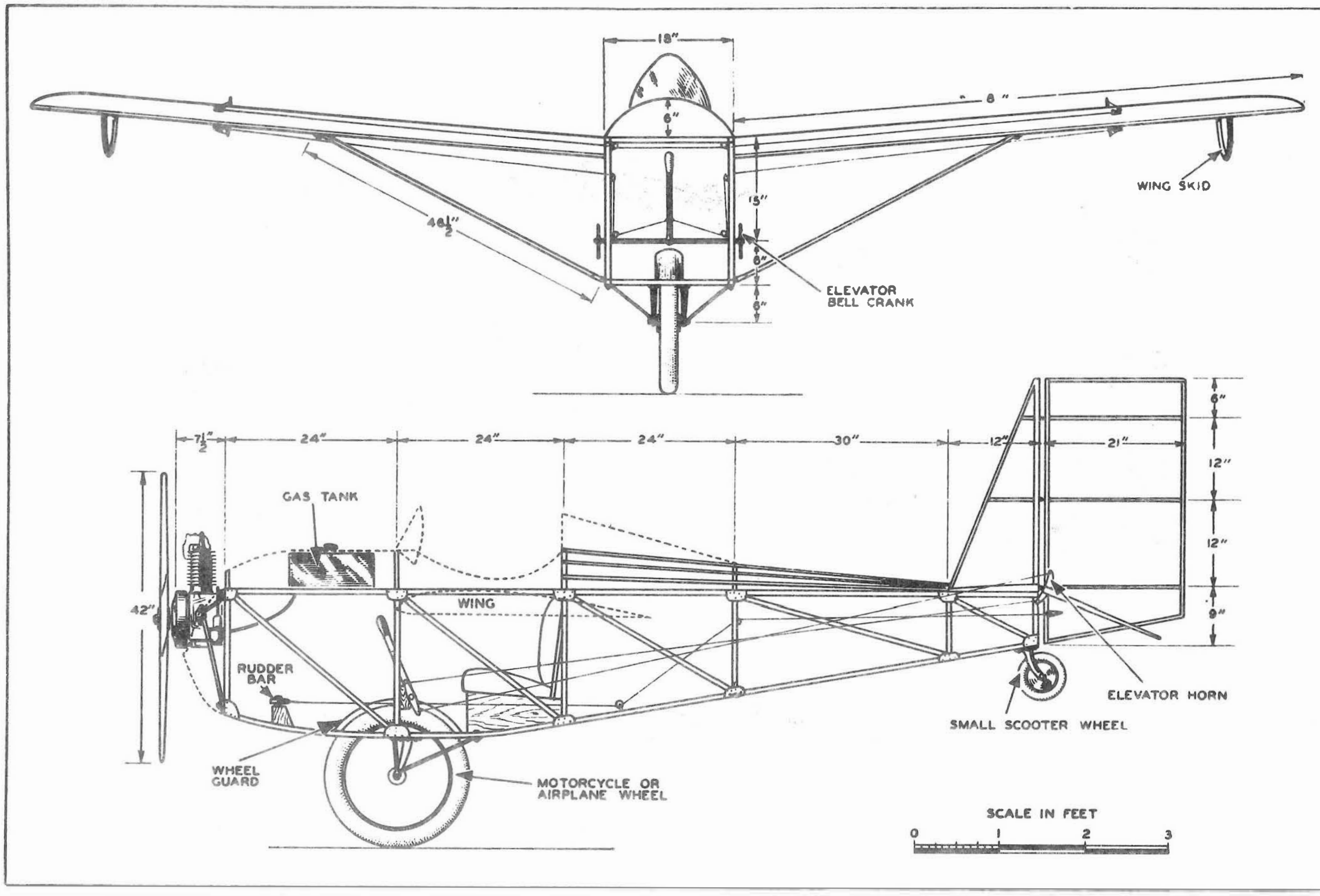
account of their tendency to stretch. I would advise genuine aircraft cable.

When everything is finished, take the machine to a smooth, level field, free from obstructions, for a try-out. You'll need someone to help you start the engine, etc., but it should not be difficult to find one, as the plane is sure to attract a large crowd of spectators. After the motor has been warmed up, have someone to run along holding a wing-tip until the ship gathers enough speed to balance. When you have attained considerable speed, lift the tail by easing forward on the stick. If a wing drops, push the stick in the opposite direction, and at the same time, give it a little opposite rudder. In making turns, the machine must be banked just as a real plane. • • •

CLAMP FOR RIBS



In the fastening of gusset plates on wing ribs and tail surfaces it is often necessary to set the plate in cold water glue before nailing. The simple clamp shown in the picture should be in every amateur plane builder's workshop. It is best to make a dozen or so and keep them within handy reach when nailing on trailing edges, etc. A pin can be run through the center wedge to keep it always with the clamp. To use it, the clamp is pinched down with the fingers and the piece adjusted at the nose, then a quick jab of the wedge will set the work tightly enough to allow nailing.



the control horns rigidly in position.

The wings are next on the program. The ribs are perhaps the most tedious part of the job, but after you get started, you'll have them finished in no time. Make the cap strips from ¼ in. by ½ in. wood, and the formers from 1 in. by ¼ in. material. The front spar is ¾ in. by 2 in., and the rear one, ½ in. by 1½ in. After the spars are completed, slip the ribs in place and glue and tack them securely. The trailing edge is ¼ in. by ½ in., and the leading edge is 1 in. by ½ in. with one side rounded off. Now make the ailerons, but do not attach them until after the wing is covered. The internal bracing consists of ¼ in. by 1 in. strips of wood. Before being fastened in place, these strips should be moistened slightly.

The landing wheel is taken from a small juvenile bicycle, or a motorcycle or airplane wheel may be used. A bicycle wheel snould be fitted with heavy-duty spokes. Saw off the lower part of the front fork of a bicycle, and weld these pieces to small metal plates. These plates are then bolted to the parallel members on the under side of the fuselage. Then attach bracing strips to the fuselage as indicated. If you want to install a heavier motor and use an airplane type wheel, you will have to modify this mounting somewhat.

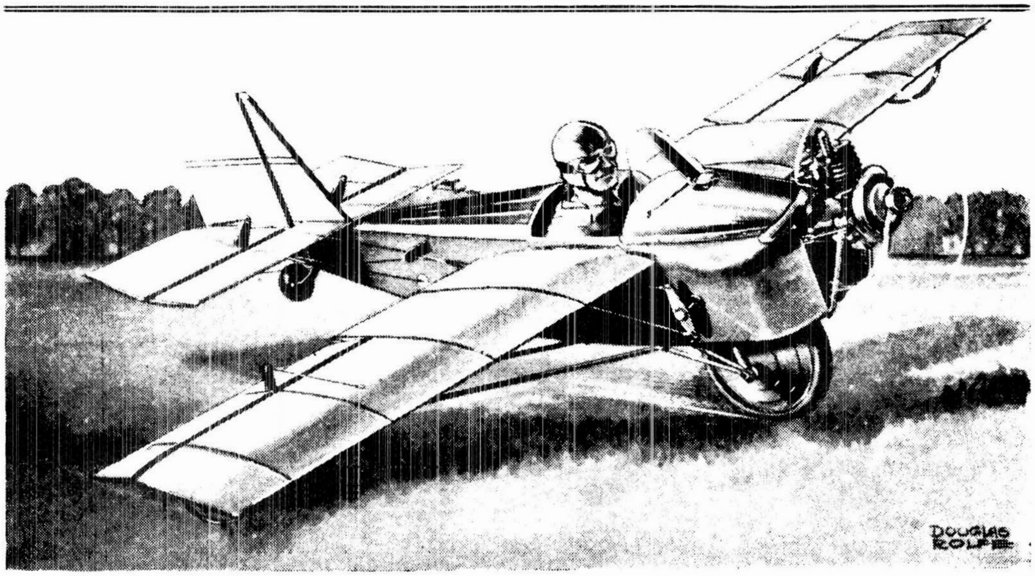
The wing attachment fittings are ordinary strap hinges. The heads of the pins are filed off to allow the wing to be removed. Make the wing struts from ¾ in. by 2 in. wood, with the edges rounded, or better still, make them of stream-line cross section.

Instructions for converting the Smith Motor Wheel may be found in the 1931 Flying and Glider Manual. If you use another engine, work out your own conversion. You can make the gas tank of any size. It is best to have this work done by a tin-smith. Install it in the position shown.

Any good quality sheeting is satisfactory for covering purposes. The wings may be supported on chairs or saw-horses while you are covering and doping them. Two coats of clear nitrate dope and two of the pigmented variety are sufficient.

The propeller may either be home-made or bought preferably bought. Its diameter depends on the motor used; use one 3½ ft. in diameter for the Smith Motor, and 4½ ft. for a motorcycle engine.

Now make and install the controls. In order to make more room, the elevator horns are outside the fuselage. These horns are made of wood, eight inches long, two inches wide and one-half inch thick. The control stick is made of wood or steel tubing. Cut a notch in its lower end and attach it to the control column with a cotter-pin. Ordinary cords may be used for the control cables, but you are likely to have trouble on



A "PENGUIN" PRACTICE PLANE

By Manley Mills

Here's a machine that will afford you all the thrills of flying, and although it never leaves the ground, its controls perform the same function as those of a full-fledged airplane. By referring to the plans you will see that it is a cross between an airplane and a bicycle. (Or should I say unicycle?)

Of course you have seen an airplane running along on its wheels with the tail in the air; and perhaps you have also seen a glider bumping along, balanced on a single skid. Then why not combine the two and use a single wheel? When the Aero-Cycle is in motion, it is balanced on the wheel by the lift of the wing and tail. The wing also relieves the wheel of some of the weight. A certain amount of skill is involved in keeping the plane on an even keel, but you will become proficient after a little practice. If the machine is to be "flown" on rough ground, you should place a small wheel in front of the large one to protect the propeller.

You may choose any suitable motor you wish, but I suggest something like a bicycle motor, such as the Smith Motor Wheel. By using a stronger wheel, even a motorcycle engine may be used. At any rate, the motor should be of at least three horsepower in order to attain sufficient speed.

The plans need not be strictly followed as they are only a suggestion, but make the control surfaces amply large and be careful where you put the running wheel. If the wheel is too far forward, the tail will not rise. On the other hand, if it is too far back the plane will likely nose over. As a general rule, the hub should be under the leading edge of the wing. Since the plane is not intended to fly, it is not necessary to use regular aircraft materials. Nevertheless, make it as strong and light as possible. White pine is an excellent material.

Make the fuselage first, using ¾ in. by ½ in. wood for the longerons and struts, and ½ in. sq. material for the diagonal bracing. The turtle-deck is made of ¼ in. plywood formers, and ¼ in. by ½ in. stringers. The motor mount will depend on the motor used, but be sure that the motor is rigidly braced to the fuselage. The lower horizontal strut at the second bay is omitted to leave room for the wheel. Two struts are placed in the position indicated in the top view drawing, and two parallel members are attached between them as shown by the dotted lines. It is to these members that the wheel is attached. Take extra care in making the joints as it is at this position that the greatest strain occurs. Make the seat as comfortable as possible since the plane has no shock-absorbers. The small tail wheel may be taken from a scooter. One of the drawings shows how to make an inclinometer for attaching to the instrument board. Another one may be attached to an upper longeron to show the plane's fore-and-aft position.

The tail surfaces are simple wood frameworks and need no explanation. Do not allow them to become warped while in the process of construction. Install

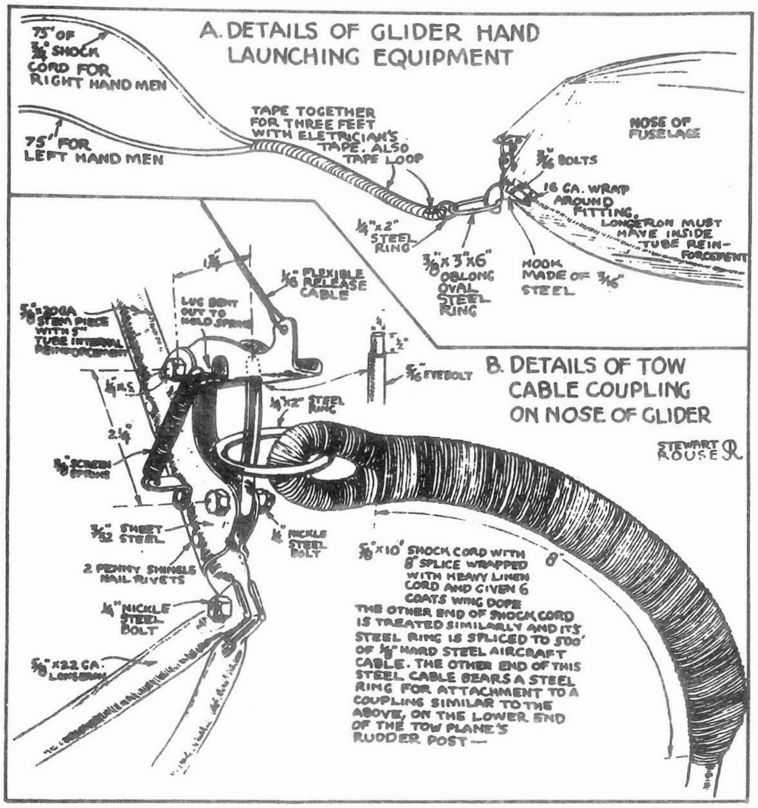


Fig. 9. Details of construction of the hand launching and airplane and auto towing equipment of the "Super-Soarer" are shown on this plate.

lapped back on itself, where it is spliced with a heavy sewing of heavy linen cord saturated with wing dope. There are 10 ft. of this shock cord with another steel ring spliced in the other end in the same way, then 500 ft. of 1/8 in. hard steel aircraft cable for attachment to the tow plane.

After the glider pilot releases the glider the tow plane flies to the landing field dragging the tow cable and drops the cable just before landing so it will not be lost.

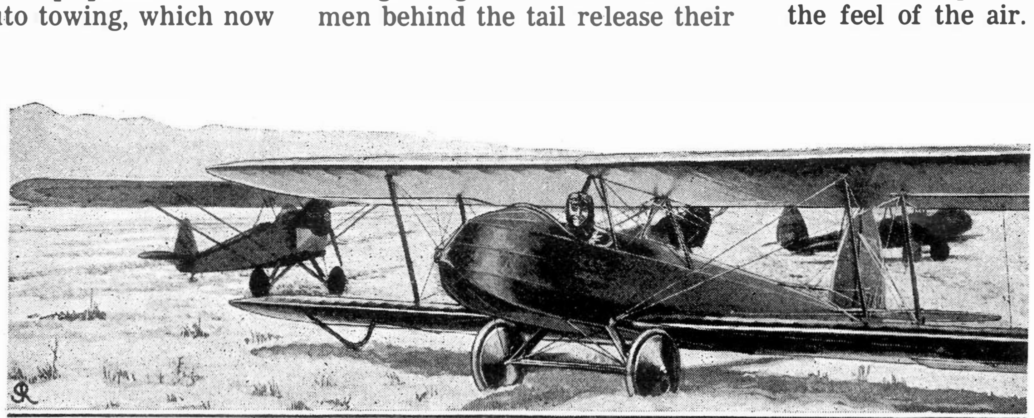
The same equipment can be used for auto towing, which now seems to be the favorite method of launching.

This is great sport, and Fig. 9, A, shows how the shock cord and hook for the nose of the glider are prepared. Tow men brace their heels in holes in the ground and hold a short length of rope tied to the tail skid. At a word from the pilot the two groups of men on the shock cord ends walk forward about 100 ft. apart until the cords are well stretched, then they run forward and outward and when the glider pilot thinks the rubber cords are tight enough he gives the word and the men behind the tail release their rope and the glider is catapulted into the air fast enough to go 100 ft. high and glide or soar a long distance, at least 1,000 ft. Beginners must be careful not to use much tension so as not to go very high, and the two crews of men should be at least 150 ft. apart at the moment of launching to preclude danger of hitting them accidentally with the glider. It is hardly necessary to add that the launching must be done against the wind.

If the glider should prove nose heavy the upper wing should be moved forward, and vice versa.

The main thing in this lightplane and glider sport is to be careful. Be sure that everything is strong and right, then go ahead with confidence and a light heart and have some fun!

Although this job is of extremely simple construction for those who have the Heath "Parasol" plans, it is frankly not a glider for the beginner unless a capable instructor is present to handle the towing auto. Those teaching themselves to glide should use a primary ship to get the feel of the air. ● ● ●



plywood, with 3/16 in. by ⅝ in. spruce stringers set in deep notches around their edges. The instrument board serves as a bulkhead for the little fairing in front of the pilot and its stringers are of ¼ in. by ½ in. spruce. All wood joints are made secure with aircraft glue and 21 gauge nails of various lengths. The little 20 gauge aluminum stub cowl that forms the front edge of the cockpit has the edge toward the pilot turned over a piece of ⅛ in. wire, similar to the edge of a bucket rim to give a rounded edge.

Fig. 5 describes, perhaps better than words can tell, just how wing beam fittings are built into the fuselage structure. The front fitting presents no difficulty, the wing end fitting merely being bolted at the bottom to the fuselage fitting marked H and its top lugs wrapped around its vertical strut, and bolted to the flattened end of the new horizontal compression strut which, with the old horizontal fuselage bottom strut, takes all the compression between the front wing beams.

As the rear wing beam fittings come at unsupported points on the longerons, a new horizontal fuselage bottom strut, and two bays of No. 12 hard aircraft wire bracing must be installed together with two struts J 2 and L 2, which complete the truss. Another horizontal ⅝ in. by 20 in. strut must be installed between the tops of these rear beam fittings.

These lower wing beam fittings must be so installed that the bottom of the wing at the rear wing beam is 1⅛ in. below the bottom of the wing at the front beam, with the ship in flying position, to maintain the correct angle of incidence.

Figures 4 and 6 should serve as guides in constructing the glider tail to replace the regular "Parasol" tail, the details of which are shown in Fig. 6. These details are all right excepting that the glider tail has longer spars and ribs due to its larger size. Follow the overall sizes given in Fig. 4 and use Fig. 6, for information on general details of construction. Note that as the front spar of the horizontal stabilizer is farther forward in the glider tail the bolt holes for the top longeron clips are spaced farther apart, as the fuselage is wider at this point than at the old spar position. The bottom wire bracing of the horizontal stabilizer no longer comes to a point at the base of the rudder post, but the rear pair of brace wires attaches there, and the front pair at the first bottom longeron fittings forward. Note that a 3/16 in. 3-ply plywood filler web is inserted glued and nailed between the cap strips of the horn rib of the elevators and rudder for stiffness.

The regular 3/32 in. control cable is used for the elevators and rudders but must be lengthened a couple of feet.

The tow cable end detail is shown well in Fig. 9. The ⅝ in. shock cord is passed through the 2 in. cable end ring and 8 in. is

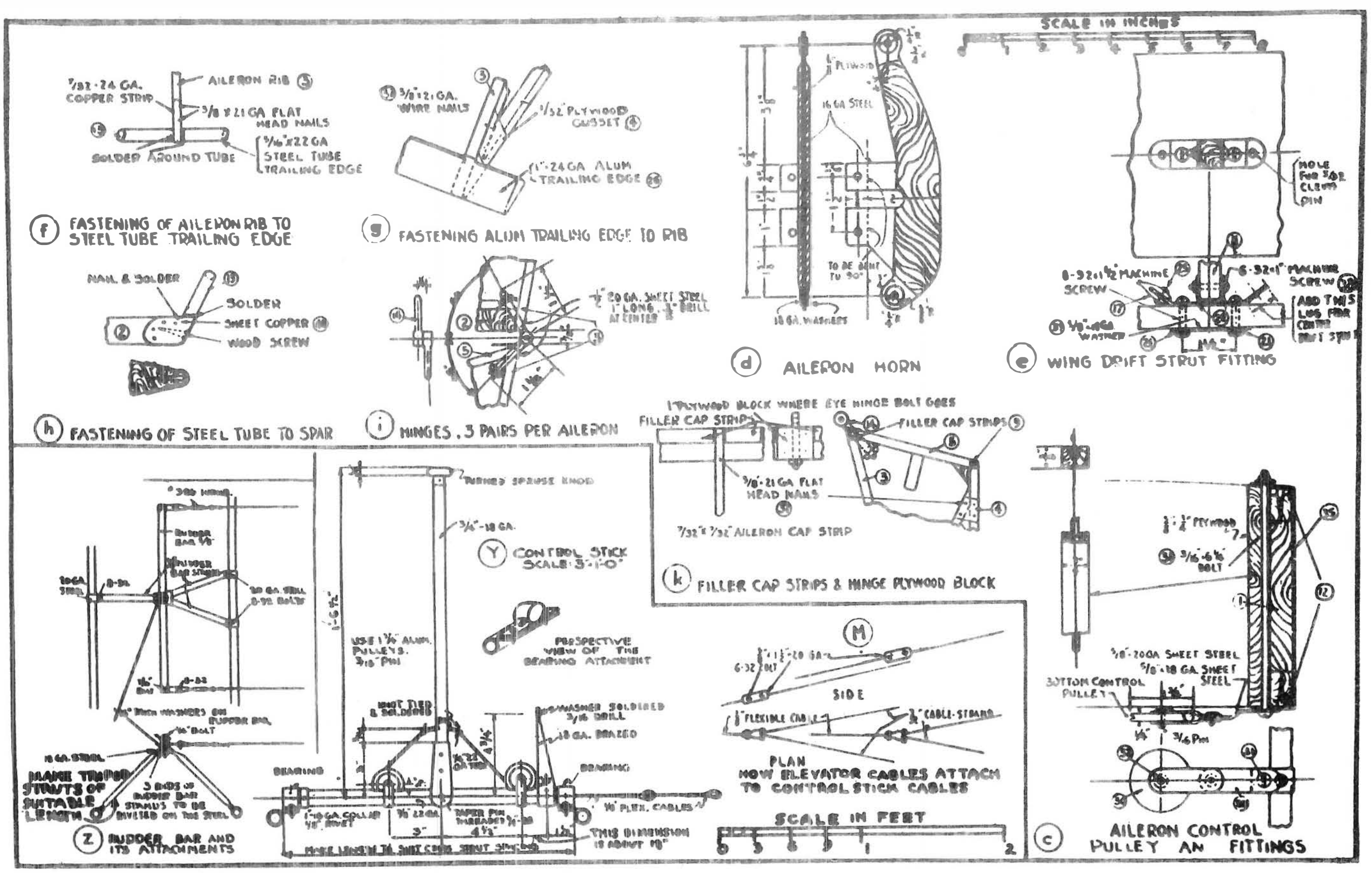


Fig. 8. This plate shows construction details of the wings and controls. The letters in the circles correspond with those shown in Fig. 2 of the first installment. Except for slight differences shown here, the wing and control construction of the Soarer is the same as for the Heath Parasol.

certificate on their factory-made ship, and have reasonable assurance that the right to a commercial license will extend to those who build their own airplanes at home provided that they use materials supplied by the Heath Air-Craft Corporation and follow exactly the Heath certified blueprints.

The workmanship and final rigging of these homebuilt Heath airplanes will then be inspected and passed upon by a licensed airplane mechanic whose name will be supplied when the builder is ready to use him. For builders whose state governments do not require a federal license on airplanes, the old reliable "Super-Parasol" will still be available. There is very little difference in these two ships. It was only necessary to increase the wing and tail area so that an approved type motor could be used, in order to get into the license classification. This has reduced the speed somewhat. ●●●

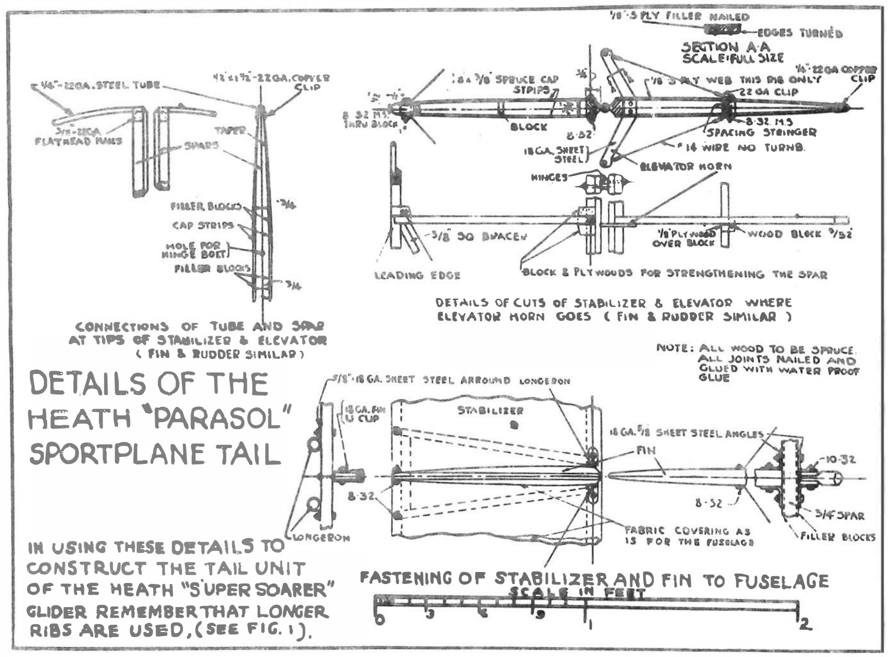


Fig. 6. A mechanical drawing of the tail unit of the "Super-Parasol." The construction of the glider tail is essentially the same, except that the dimensions are larger. See Fig. 4 of first installment.

PART 2

Part I of this article told what changes were necessary in the Heath "Super-Parasol" plans, to convert this job into a soaring biplane glider. The first installment started you well along on your work, so this time we will start with the control assembly, winding up the job before we get through.

The only changes necessary in the control stick assembly are to install a torque tube long enough to put the aileron cable horn to the rear of point F, Fig. 4, to mount the rear torque tube bearing in front of this aileron horn, and to mount the torque tube underneath the horizontal bottom struts instead of above them. It may be necessary to change the length of the rudder bar tripod legs somewhat.

Fig. 9 shows how the tow cable coupling is made and installed on the stem piece. Make the stem piece of ⅝ in. by 20 gauge seamless steel tubing with a liberal reinforcement of the next smaller size tube slipped inside. The 1/16 in. flexible release cable passes through a guide at the top of the stem piece and thence back through a hole in the 3/16 in. 3-ply plywood instrument board at a point just below the altimeter where it terminates in a 2 in. steel pull ring. Make this coupling as neatly as possible for it must work smoothly and release the tow cable end ring when the cable is under tension. The hook for holding the shock cord for hand launching is clearly shown in Fig. 9, A. Cut it out of 3/16 in. cold rolled sheet steel and clamp it to the left longeron at the lower end of the stem piece.

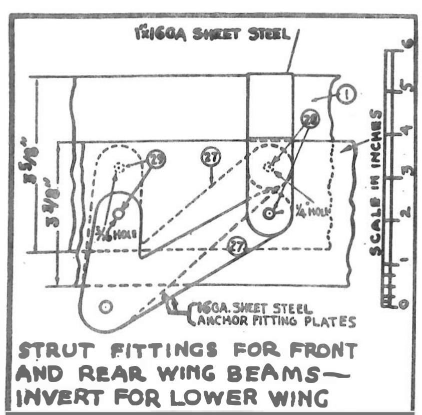


Fig. 7. A drawing of the wing beam strut fittings. Eight will be used in the construction.

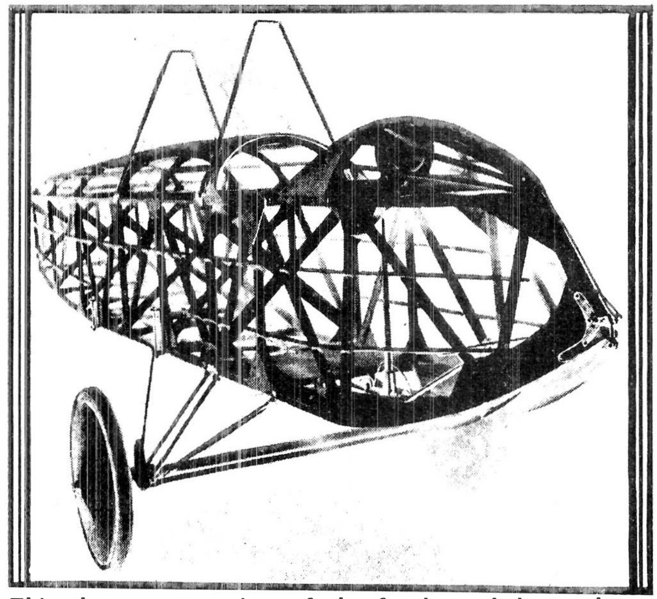
The side fairing of the fuselage consists of two ¼ in. by ½ in. spruce stringers on each side running the full length of the fuselage and fastened to each vertical strut with a serving of linen rib cord passed through a 3/16 in. hole bored through the stringer. These cord wrappings must be saturated with wing dope. Bottom fairing is applied in a similar manner.

The turtleback fairing of the fuselage top consists of semi-circular bulkheads of 3/16 in. 3-ply

glued and screwed with a few small screws driven along the center line.

The new wing spar butts must be heavily reinforced on all sides with plywood as the spars are so small that there is not much left after the ¼ in. bolt that attaches the spar end to the fuselage is passed down through the spar.

If it is desired to make a two-seat glider a "side walk" of 3/16 in. plywood must be attached to the reinforced last pair of ribs at the left wing butt. This is pretty well shown in the photos in Fig. 1.



This three-quarter view of the fuselage skeleton shows how the pilot's compartment has been placed forward to compensate for the weight of the motor used on the "Parasol."

The wings when finished are covered in the regular way with aircraft cloth or a good grade of unbleached muslin sheeting. When properly covered give them two coats of clear and two of pigmented wing dope. Four coats is enough as more will warp the ribs. The tail surfaces are covered in the same way.

The landing wire upper ends are both held by a strap fitting secured between the flattened top of the rear pair of center section struts and the wing by the two ¼ in. nickel steel wing butt bolts, see Fig. 3, C. These wing butt bolts also hold a pair of double ended cable lugs under their heads to hold the old "Parasol" anti-drag and the new 3/32 in. drag cables of the center section struts.

The flying wires are held at their lower ends by a sheet steel double shackle secured in the old "Parasol" front strut fitting by a 5/16 in. nickel steel bolt, see Fig. 3, B. This drawing also shows the outlet for the aileron cable admirably.

In Part II we will take up the control system, the lower wing fittings, the cowling and fairing, tail assembly, and the towing and launching gear.

Complete working blueprints of both the Heath "Super-Parasol" and the "Super-Soarer" may be purchased from the Heath Aircraft Corporation, Niles, Mich. This company also is in a position to furnish you with parts and materials, either rough or knocked down ready for assembling.

And while on the subject of the Heath "Super-Parasol", it might be apropos here to mention that the Heath Company is now developing the "LN" Parasol, which will meet the demand for a lightplane that will be eligible for a commercial license.

This model is built in strict accordance with the Department of Commerce regulations, and with the same fine materials that Heath has always used. They are applying for an approved type

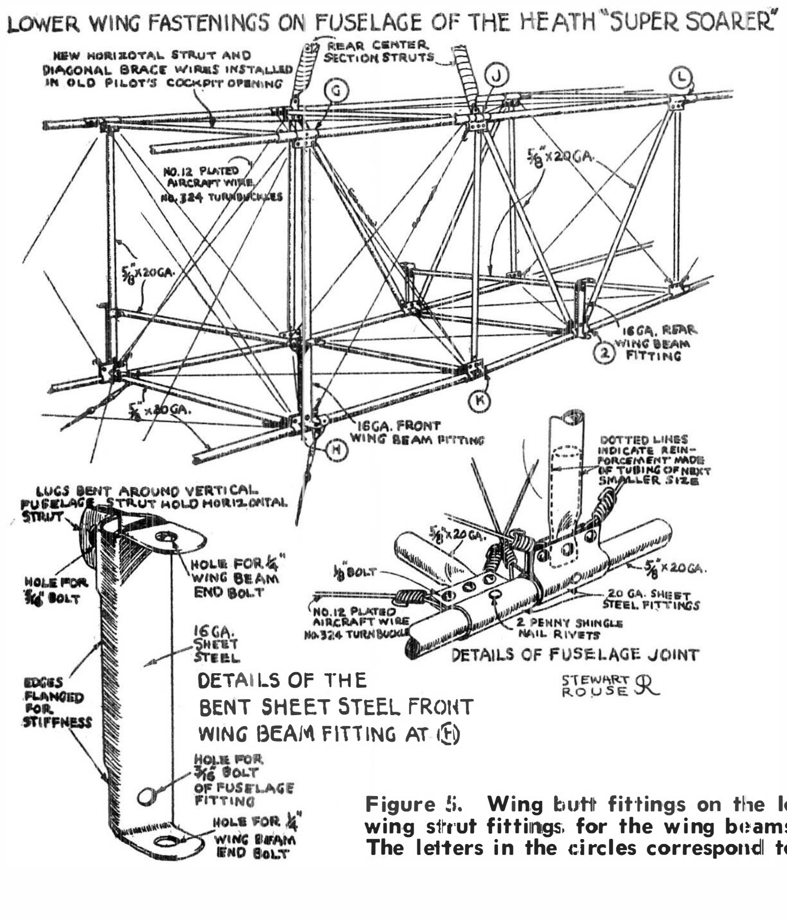


Figure 5. Wing butt fittings on the lower longerons of fuselage and wing strut fittings for the wing beams are shown in these drawings. The letters in the circles correspond to those in Figure 4.

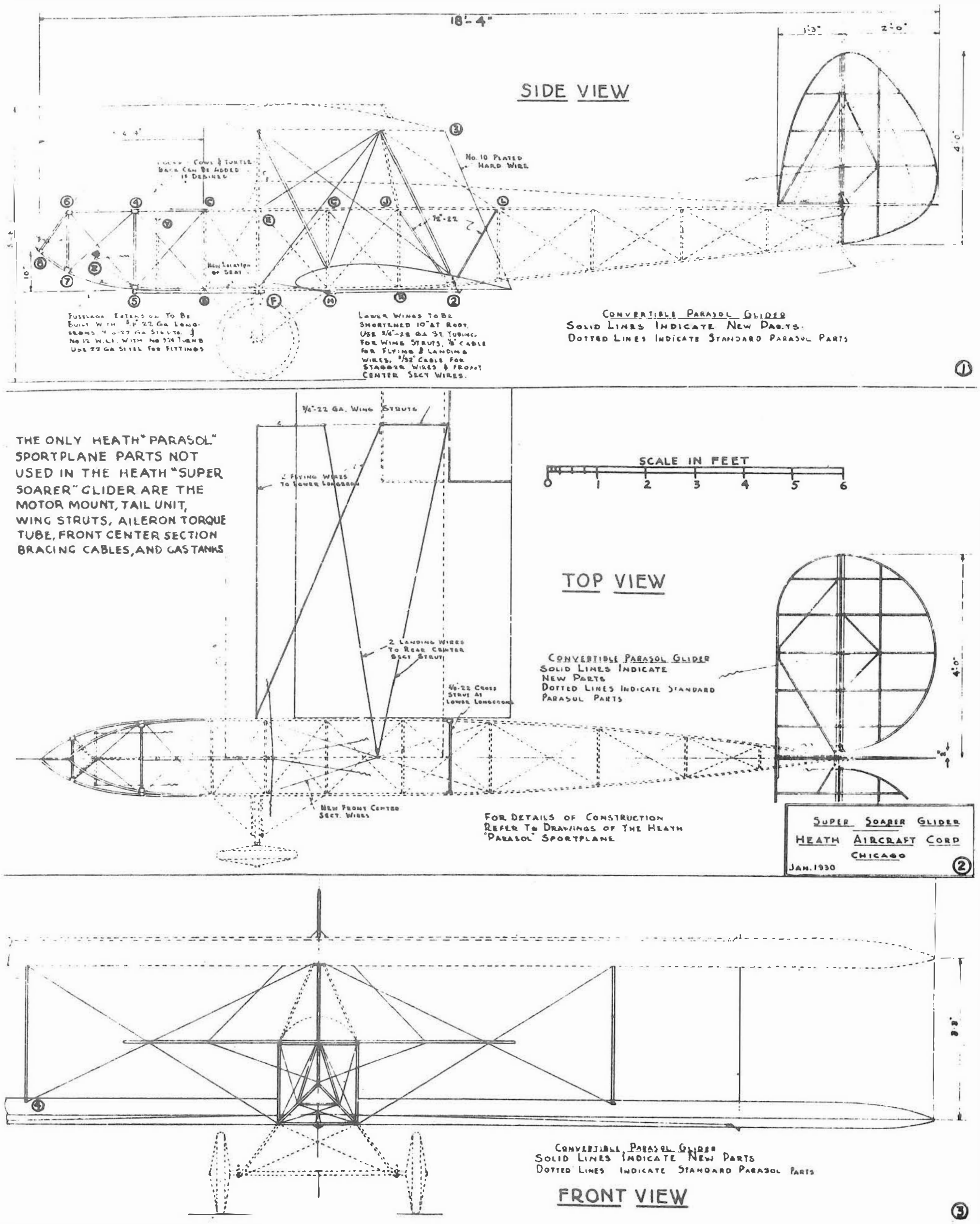
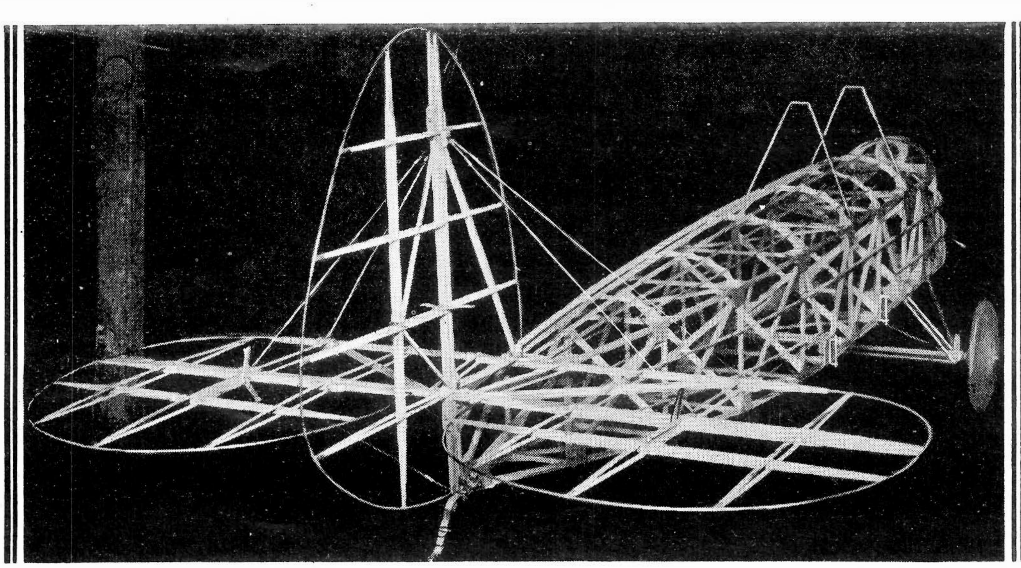


Figure 4. A three-view mechanical drawing, showing how the Heath "Parasol" sportplane is converted into the Heath "Super-Soarer" glider. The dotted lines show the standard "Parasol" parts used, while the solid lines indicate new parts necessary in converting the sportplane into the soaring glider.



This photograph of the "Super - Soarer" skeleton shows how the tail assembly has been enlarged. Note that the front spar of the horizontal stabilizer is farther forward in the glider tail than in the "Parasol", and that the bolt holes for the top longeron tips are placed farther apart, as the fuselage is wider.

Here is one of the greatest of gliders—"The Heath Super-Soarer" which was designed by the pioneer of lightplane designers and is the only type of glider to successfully perform a loop. Many parts of the famous Heath Super-Parasol are used in constructing the glider.

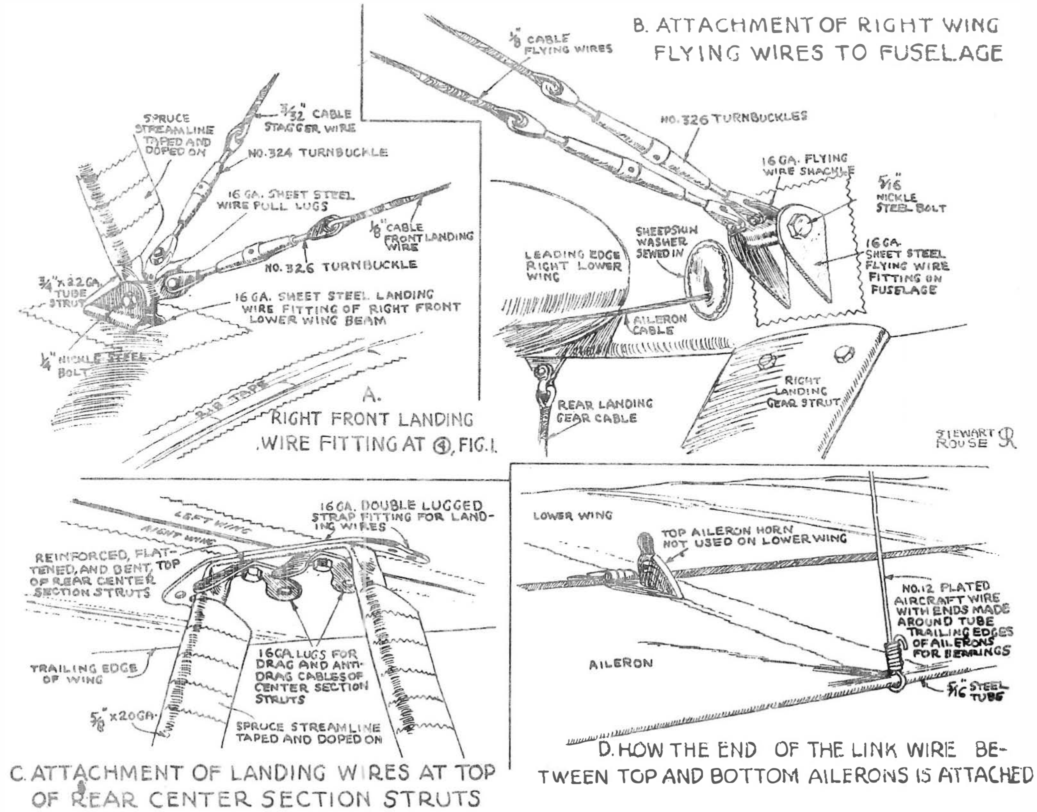


Figure 3. Strut, wire, and aileron details which will be helpful in converting the Heath "Parasol" into the "Super-Soarer." It will be noticed that the top aileron horn is not necessary on the lower wing, while the bottom one will not be used on the upper wing, since the two ailerons work together.

1/4 in. nickel steel motor mount bolts now must hold the flattened ends of the pilot's compartment longerons to the flattened tube ends of the fuselage longerons. The detail drawings will show how joints are made.

The strut ends are reinforced with two 1/2 in. pieces of the next size smaller tubing slipped into the strut ends which are then flattened with a vise while red hot, and finally drilled for the fitting bolt. The sheet metal fittings are made of 20 or 22 gauge half hard cold rolled sheet steel which is first bent around a piece of the tubing used and then mashed flat in the vise to a shape like that shown in Fig. 5. The side panels of the pilot's compartment are made first, the hard wire bracing is installed and then the bottom and top horizontal struts are installed. While bending, the 5/8 in. by 22 gauge longerons should be filled with sand and the ends plugged tightly with hammered in wood stoppers. The sand will prevent the tube from kinking and becoming weakened. Each sheet metal fitting is secured against sliding along its longeron by drilling through it and the longeron and inserting a rivet made of a two-penny shingle nail. The hard wire bracing is made of No. 12 hard aircraft wire and No. 324 turnbuckles. The wire ends are made as shown in the fuselage joint detail sketch of Fig. 5. The loops at the wire ends are formed by bending the wire around two 1/4 in. bolts fastened parallel and vertical 1/16 in. apart in the jaws of the vise. This trick is easily acquired, the main points being never to scratch, dent or split the wire, and never to bend it twice in the same place. It is cut by filing it through.

The seat is made of 20 gauge aluminum sheet, and extends from F to D, Fig. 4. It is secured by wrapping its edges around the longerons and horizontal struts and fastening them back to the seat bottom with 1/8 in. bolts spaced 3 1/2 in. apart. A seat back is made of 1/8 in. 3-ply plywood or other piece of 20 gauge aluminum. A regulation safety belt should be installed with its ends attached to the fitting F and the corresponding fitting on the other longeron.

Fig. 2 shows the construction of the new lower wings and points out that they are really regular "Parasol" wings shortened 10 in. at the root at the A-A line on the drawing. On the lower wings the sheet steel wing strut fittings are mounted upside down to make an attachment for the 3/4 in. by 22 gauge steel tube interplane struts' lower ends, and to hold the outer ends of the landing wire cables.

The wings are made in the regular Heath way with front spar of 5/8 in. by 3 5/8 in. cross section and rear spar of 3/4 in. by 3 3/8 in. cross section. Regular Heath Warren truss type ribs are used and and the internal drag bracing consists of 5/8 in. by 5/8 in. drag struts and 14 gauge hard wire with No. 324 turnbuckles.

The regulation aileron control cable pulley system is used, employing only the top pulley on the upper wing and the bottom pulley on the lower wing. Fig. 3, at the lower end of stem piece. certificate on their factory made D shows how the lower and upper aileron steel tube trailing edges are connected with a piece of No. 12 hard wire, the length of which is adjusted with a No. 324 turnbuckle.

It might be well to state here that it is now standard practice to reinforce the front wing beam at the wing strut point for 2 ft. 9 in. with a piece of wing beam

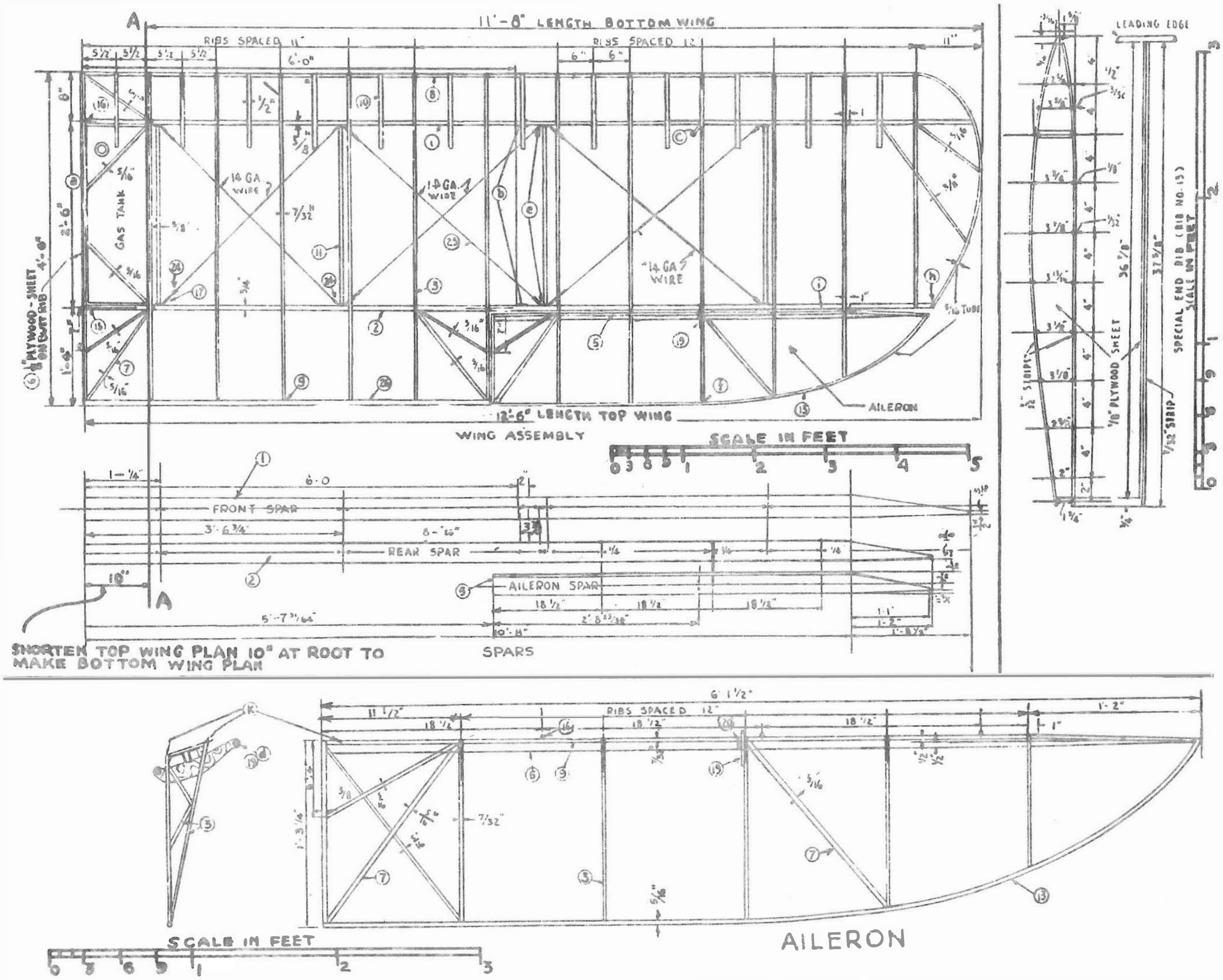


Figure 2. The high-lift wings around which the "Super-Soarer" is designed. The figures in the small circles are reference numbers accompanying the instructions issued by the Heath Company.

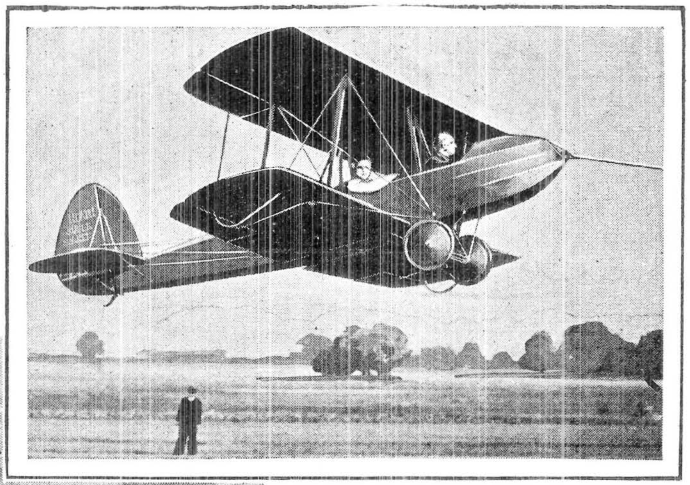
them were. As a successful glider relies for its surprising soaring ability mostly upon a light wing loading, Heath soon came to the conclusion that the Heath "Parasol" sportplane would make a successful glider if another pair of wings was attached to make it a biplane and the pilot and pilot's cockpit substituted for the motor and motor mount. His supposition proved correct and the Heath "Super-Soarer" glider will soar on any current of air that rises faster than the glider comes down, with its 18 to 1 gliding angle.

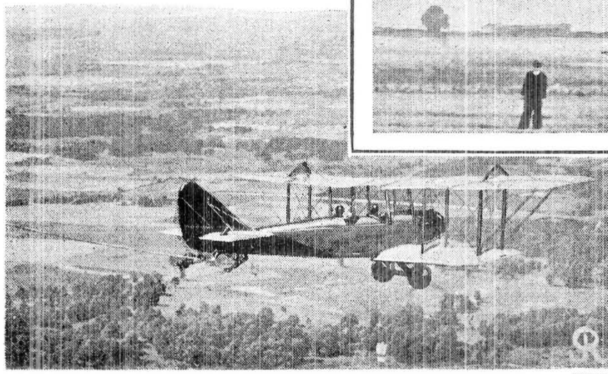
The first one in which Ed made the loops just described had a wooden fuselage made to the same dimensions as the regular Heath "Parasol" fuselage. This fuselage had ¾ in. by ¾ in. spruce longerons and struts, arranged in a Warren truss. The joints were secured with 3/32 in. 3-ply plywood gussets held with airplane glue and 3/32 in. by ⅝ in. wood screws. This style of fuselage is very successful for general glider work and blueprints have been prepared for its construction.

But the type of Heath "Super-Soarer" which will probably have the greatest vogue among amateur airplane builders is the "Super-Soarer" which is made by converting a bolted type fuselage Heath "Parasol" sportplane into a biplane glider. It has a wonderful advantage over most gliders in that while it is a successful glider, it also becomes a strong, successful, power airplane by the shedding of its lower wings, and the installation of a suitable motor. This advantage will be appreciated by glider owners who have tried to convert their flimsy gliders into powered airplanes with indifferent success.

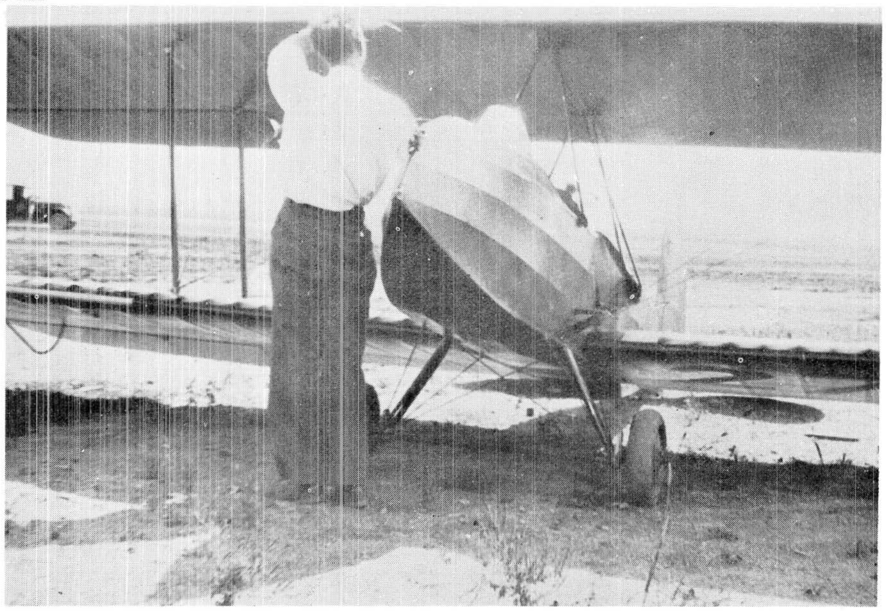
Due to the fact that space is limited I will not try to describe the entire building of the ship, but only to describe the building of the parts and changes necessary to convert a Heath "Parasol" sportplane into a Heath "Super-Soarer" glider. Those who missed the plans for the "Parasol" in the 1929 Flying Manual may still obtain this manual by sending $1.00 to this magazine, or the large blueprints may be obtained from the Heath Aircraft company.

A close inspection of Fig. 4 will give a clear idea of the work to be done as the regular "Parasol" parts are shown in dotted lines. It will be seen that the four





Above is shown the "Super-Soarer" taking the air as it is towed behind an automobile. At the left is this glider being towed by an airplane—the only method of launching by which sufficient altitude may be obtained for the loop. Towing by aircraft is now barred by the Department of Commerce unless a special permit is obtained.



Pre-flighting the "Super-Soarer"

it had traveled 100 ft., the glider was skimming along about five feet high, and Ed was flying it as fast as possible to cut down resistance and allow the Standard to get up flying speed. After the Standard had gained a little altitude, Ed nosed up a little and the way that glider soared up to about 100 ft. above the tow plane was so sudden and thrilling to see, that an exclamation of pleased excitement burst from the little crowd around me.

The airplane and glider now made two wide circuits of the surrounding country and finally flew right across the flying field at an altitude of 1,200 ft., flying down wind. Suddenly close observers saw the Standard gain rapidly on the glider which seemed to be trying to point its nose at the zenith, then, while in this position the tail was blown upon by the following breeze, and as the tail had little inertia, and great leverage on the rest of the ship, it moved in a quarter circle until the ship was on its back, from which position Ed dived it right into three more loops just like the first. After this thrilling exhibition we could hear Ed's voice which was one of the most penetrating in the aviation world, (I have heard him explain things to students when almost 1,000 ft. up) telling us to stand back so he could land where he started from, which he almost did, but this was no surprise as he often won spot landing competitions at air meets in a Heath "Parasol."

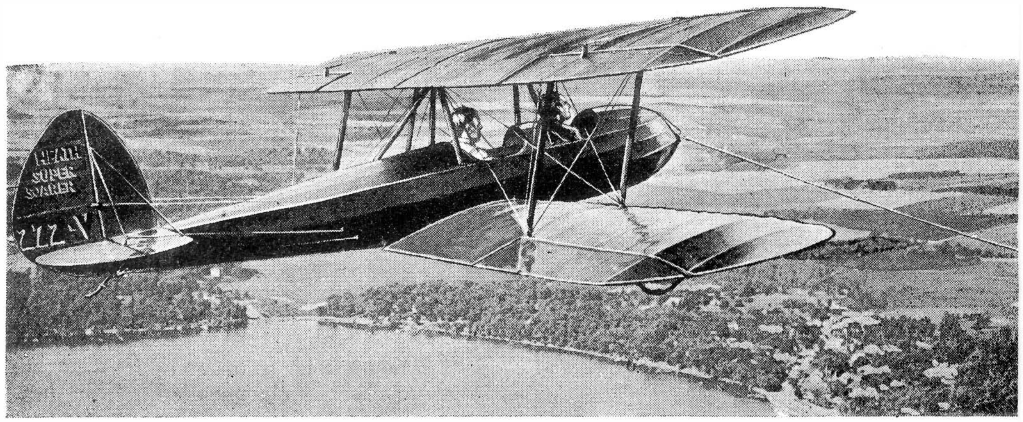
Ed says that when released from the tow plane the glider drops from 60 back to 25 mph so suddenly that one must take care not to bump his head against the instrument board, and if loops are to be made, they must be made right away before the extra speed is lost, or the glider will stall hopelessly before it even points straight up, and a loop will be impossible. He also states that a glider loop has to be made from a down wind start, as the wind is relied upon to blow the tail around. Diving for speed does not help, for the glider is so lightly loaded and has so much resistance that it dives but little better than a parachute. It won't dive as fast as the Standard can pull it!

About two years ago when the glider first became really popular, Heath could not but note what flimsy contraptions most of

PART 1

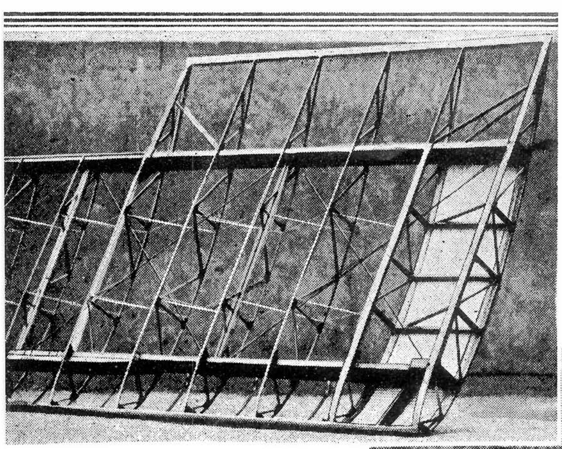
THE HEATH "SUPER SOARER" GLIDER

by Stewart Rouse



Heath Field is only seven miles from my house, so when one crisp, cold day the late Ed Heath roused me from bed with an early phone call and told me to come out and see something peppy happen at his experimental field, I was not long in getting there.

When I drove into the lane leading to the grove of trees where the hangar is, I saw that I was bringing up the rear of a little parade of cars carrying newspaper men and news-reel photographers, most of whom were drifting over to where a beautiful biplane glider less than six feet tall stood poised for flight in the snow. A thin glistening steel cable was attached to a coupling at the nose, releasable from the pilot's instrument board in the snug cockpit, in the nose of the fuselage ahead of the wings. I might note here that the instrument board bore only this cable release and an altimeter. My eye naturally followed the line of the steel cable and there about 500 ft. away I could see the old Standard J-1, OX-5 motored war-time training plane, which Ed kept in wonderful condition for just such jobs as this, for what could be better than the old Standard, with its 62 mph top speed, for glider towing? We could hear the motor faintly as it ticked over slowly, and presently a small figure jumped down briskly from the wing sidewalk of the huge old kite, and with a few parting instructions to his pilot, Jim Lambert, Ed Heath waded back through the snow to our end of the cable, letting the cable slide through his gloved hand.



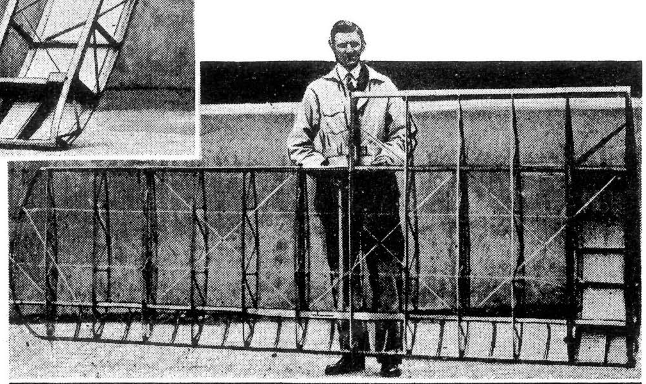


Fig. 1. These two photographs show the construction of the new lower wings, which are really regular "Parasol" wings shortened 10 in. at the root. Note how the sidewalk is applied on the lower left wing butt. Regular Heath Warren truss type ribs are used and the internal bracing consists of drag struts and 14 ga. wire.

"Hello, Stew!" cried the dean of lightplane builders, with a cheery smile, "I see you're on the job!"

The newspaper men prevented any further conversation between us, and the news-reel men nearly broke their cameras getting pictures of Ed, dressed for arctic upper air gales, as he climbed into the cockpit.

He motioned us to stand clear, gave Lambert a pre-arranged signal, the motor of the Standard commenced its roving song and the big ship 500 ft. away moved off with the glider in tow. Before

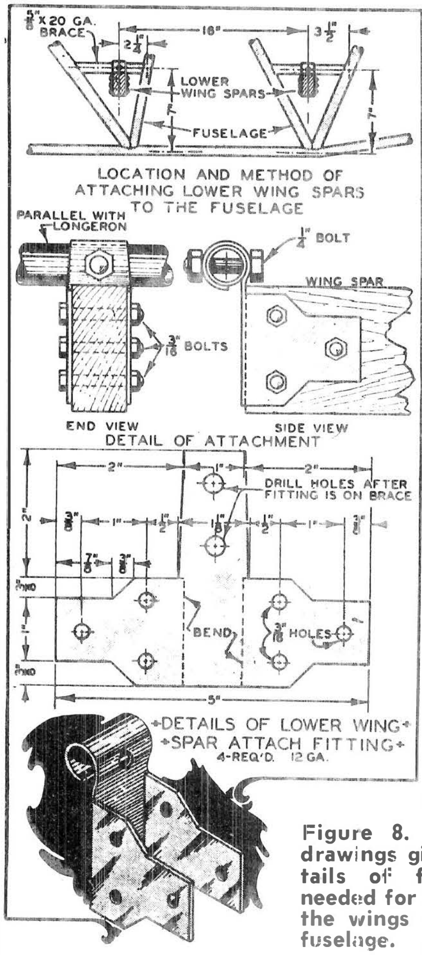
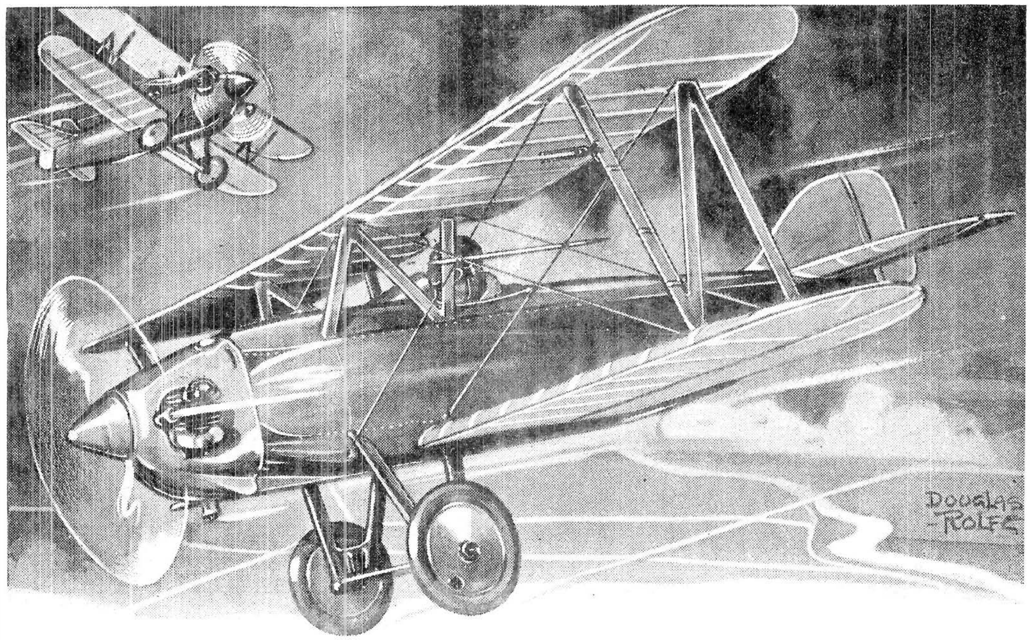
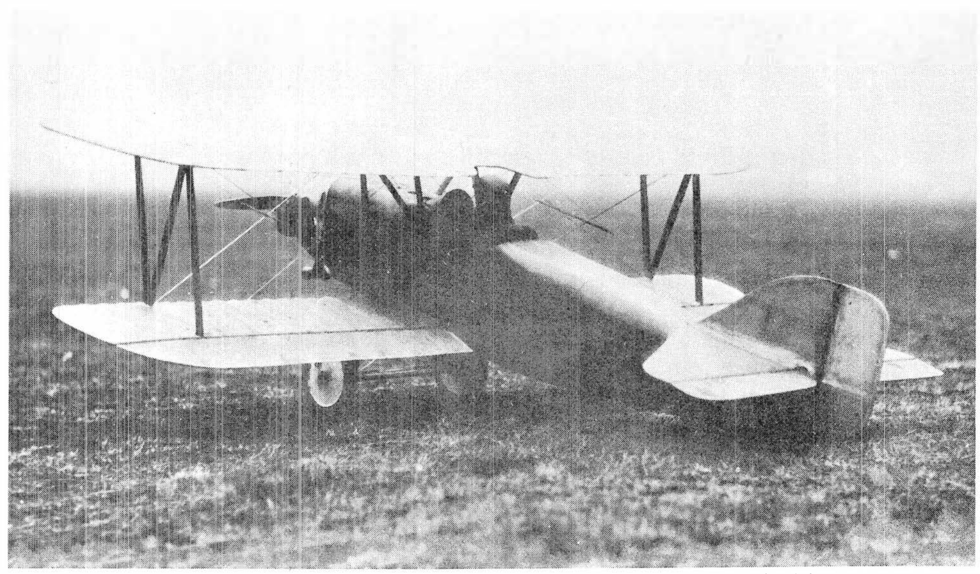


Figure 8. These drawings give details of fittings needed for fitting the wings to the fuselage.



Powell racer had clean lines.



Air Force Photo from Jack McRae

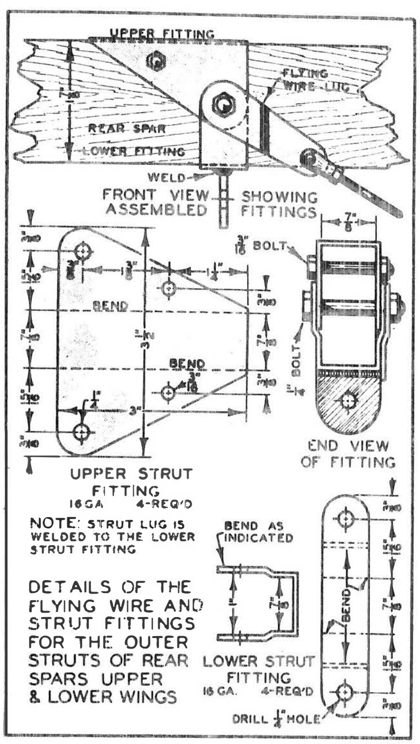


Figure 10. Above are shown detailed working drawings of the flying wire and strut fittings for the outer struts of the rear spars on both upper and lower wings of the Powell Racer.

Instruments

The only instruments needed are the oil gauge, tachometer, altimeter and switch. Others are of course desirable, but you can buy what you want at the convenience of your purse.

Struts

The center section struts are of 1 in. by 20 gauge streamlined steel. They may be made adjustable if so desired. The front center strut is 15½ in. long and the rear one is 15 in. When these have been laid out and spot welded the diagonal is cut to fit. They are then fitted to the fuselage and welded.

The front outer bay strut is 30¾ in. long and the rear 30⅜ in. The diagonal is cut to the proper length before welding. The flying and landing wires are of ¼ in. streamline cable, although stranded cable may be used if preferred. Before ordering the streamline wire it is the best policy to set the plane up and block the wings to their proper positions; then measure the lengths.

Covering

Cover the ship with a good grade of airplane fabric and give six coats of dope. Tape the ribs and wings carefully, for that makes a lot of difference in the looks of the ship. Use pigmented dope for the last three coats, as the cloth will not stand sunlight otherwise.

• • •

around the contour of the rib and nail in place accurately.

Inside of this place two more cap strips, pushing the middle one in place and nailing the inside strip. This middle one is the cap strip of your rib. Now you are ready to place the spar openings, which are illustrated on Fig. 7, in their correct locations.

After these are located and their correct size determined, make a block of that size and put it in the spar place. Now cut the 1/16 in. plywood to the contour of the rib, place it over the cap strip, glue and nail with 3/8 in. by 20 nails with a flat head. Then place the other cap strip on the opposite side and glue and nail it in place. After all the ribs are made, sand them up and fit to the spars.

A wing splice in the spar is not necessary if a piece of spruce can be obtained which is long enough, but in the event that you have to splice the top wing spar in the center, make it a diagonal splice 16 in. in length, wrap with rib cord and glue.

In rigging the wing it is easiest to measure out from the butt about three feet and make a mark on the spar. Then tighten and loosen the wires until it is the same distance diagonally from the wing butt to the mark on each spar. Give the wing a coat of good varnish before covering.

The Ailerons

The ailerons are of the semi-balanced type and are operated with a torque tube from the fuselage bell cranks. There are four hinges on each aileron, and these are made from 16 gauge steel 3/4 in. wide. Details for these hinges, as for all other parts of the aileron, are clearly shown on Fig. 6. This type of hinge is the best if care is given in construction, but they must be assembled as the aileron is built if they are to be in line and operate smoothly.

The aileron ribs are the regular ribs with two inches cut out immediately behind the wing spar. The aileron spar depth is then gotten from the inside measurements of the cap strips. The trailing edge is made from a 1 in.

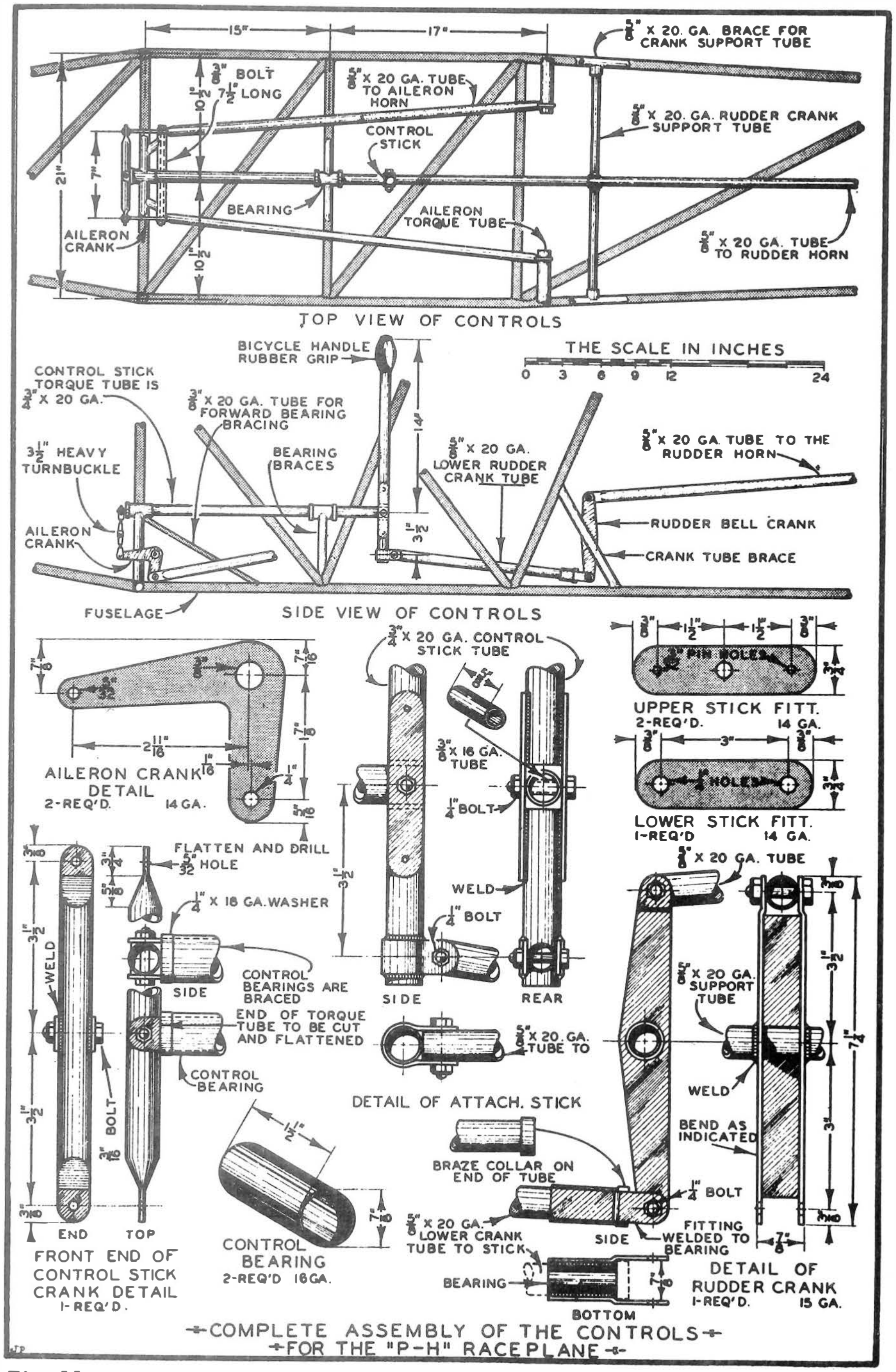


Fig. 11

wide strip of aluminum, bent in a "V" shape and secured by small strips of brass nailed around the aluminum and onto the rib cap strips. No other instructions are needed here, as the drawings are given in minute detail.

The Control Stick

This is another part of the ship which can be moved around to suit the pilot. There is not much room in which to play around, but the person who is to fly the ship should see that the stick and foot pedals are placed where they will permit the most comfort. The draftsman has illustrated the entire control system in such minute detail in Figs. 9 and 11, that further comment would be superfluous.

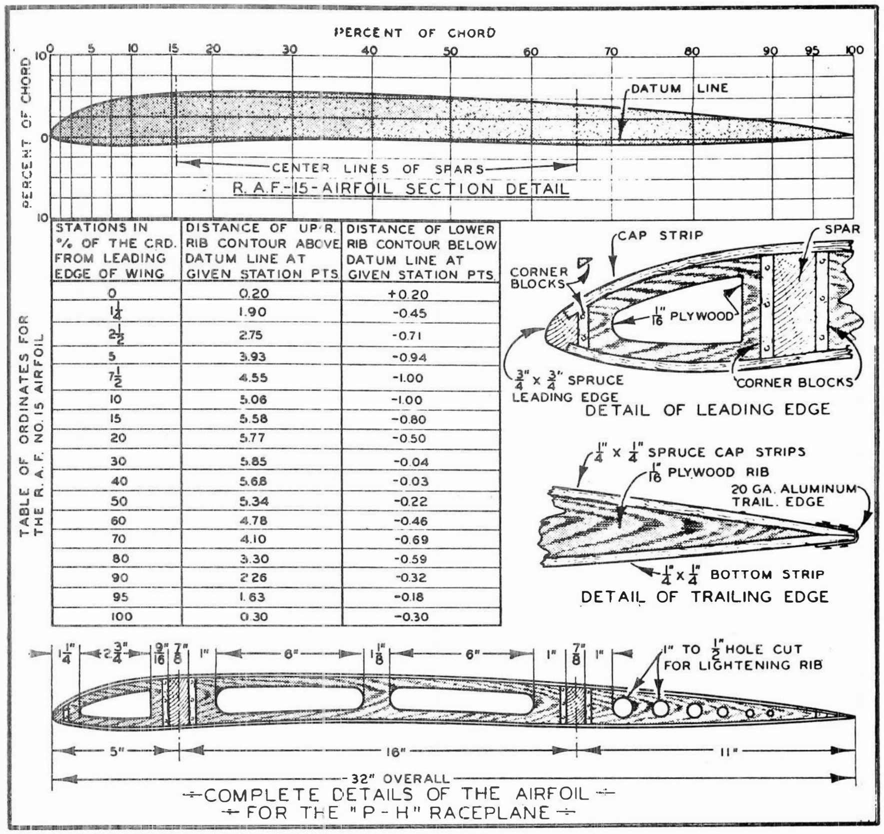
The tail skid may be made of either steel or wood, but for this size ship wood will probably be the best, although the drawing shows it constructed of steel. This is a matter of personal choice. If you decide upon wood, use ash, and follow the general size and shape as shown on Fig. 9.

in. long, with a 3/16 in. bolt put through the end.

The Wings

The wings are of conventional design with the same bracing as you will find in other wings. A glance at Figs. 4 and 7 will reveal their simplicity. The spars are the acme of simplicity, as they are solid. But be sure and pick a very good piece of spruce for each spar, as they are the heart of the wings. In drilling holes for the wing fittings, be sure to make a clean bore, being careful not to let the drill wobble in the wood, as this causes a weakness of the spar at that place and gives a poor fitting. The leading edge is put on with glue and nails and the ribs are secured to the spar in this way.

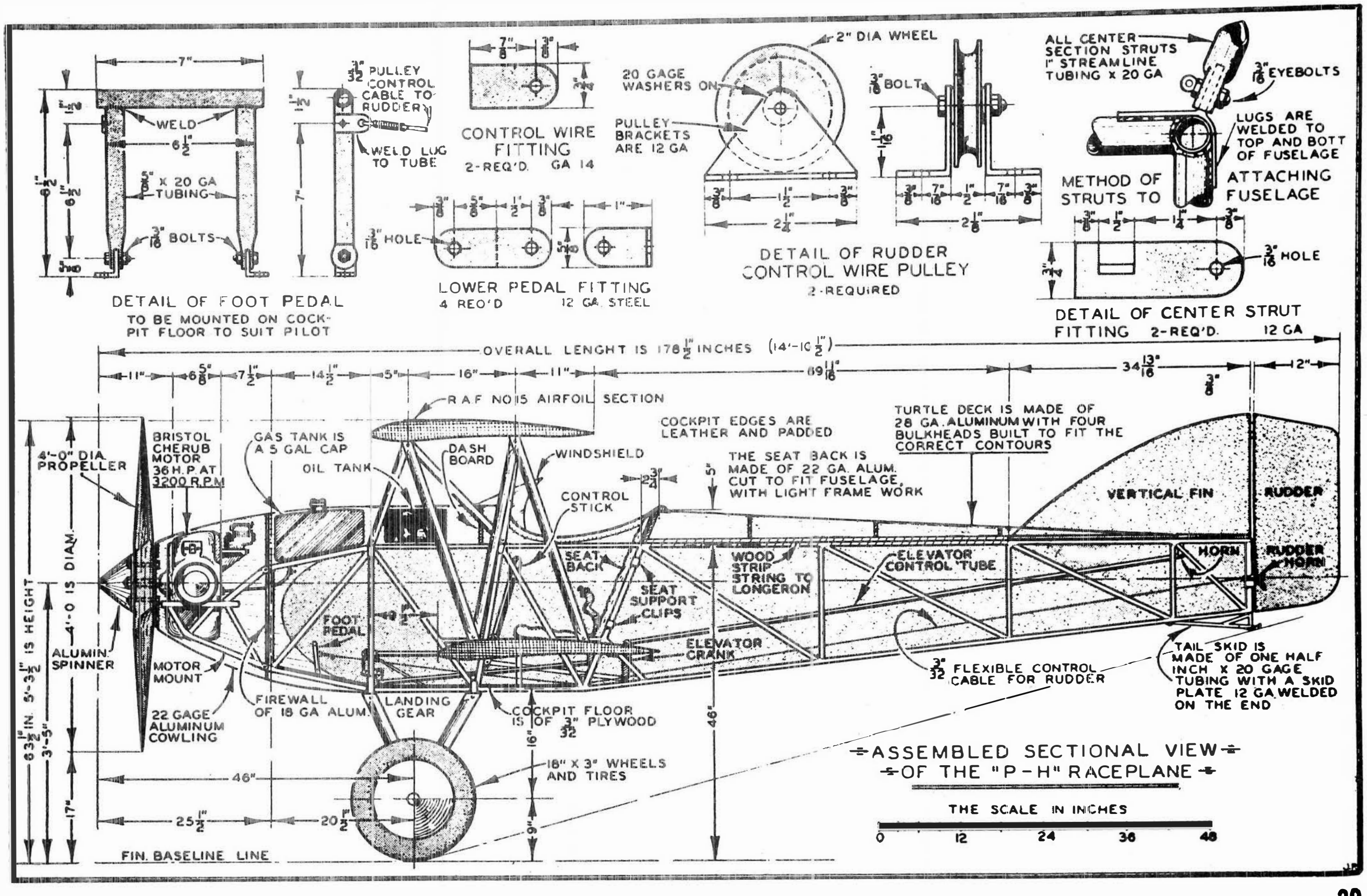
In making the ribs, it is well to stress the fact here that these are very important parts of the plane and should be built accordingly. Lay out an outline of the rib on a piece of heavy brown paper and put it on a board that is smooth and level. This board should be at least 38 in. long and 6 in. wide. Lay a cap strip on the outside of the line all the way



STATIONS IN % OF THE CRD. FROM LEADING EDGE OF WING	DISTANCE OF UPPER RIB CONTOUR ABOVE DATUM LINE AT GIVEN STATION PTS.	DISTANCE OF LOWER RIB CONTOUR BELOW DATUM LINE AT GIVEN STATION PTS.
0	0.20	+0.20
1¼	1.90	-0.45
2½	2.75	-0.71
5	3.93	-0.94
7½	4.55	-1.00
10	5.06	-1.00
15	5.58	-0.80
20	5.77	-0.50
30	5.85	-0.04
40	5.68	-0.03
50	5.34	-0.22
60	4.78	-0.46
70	4.10	-0.69
80	3.30	-0.59
90	2.26	-0.32
95	1.63	-0.18
100	0.30	-0.30

Figure 7. The Racer uses R.A.F. Airfoil, which is shown in detail here along with the table of ordinates. Spruce cap strips and 1/16 in. plywood are used in constructing ribs. 42 ribs are needed.

Fig. 9



Now for the axle. This should be a piece of 22 gauge chrome-molybdenum round steel tubing 1 in. in diameter and at least 54 in. long. This should be placed in the axle guides and the collars should be brazed at the points shown in the drawing. The axle should not be sawed to length until after you have the wheels on and the gear fitted to the fuselage, and then enough of the axle should be left to permit the placing of a hub cap. This can be made from a 1 in. inside diameter washer and a piece of $1\frac{1}{8}$ in. by 16 gauge steel tubing about $\frac{3}{4}$

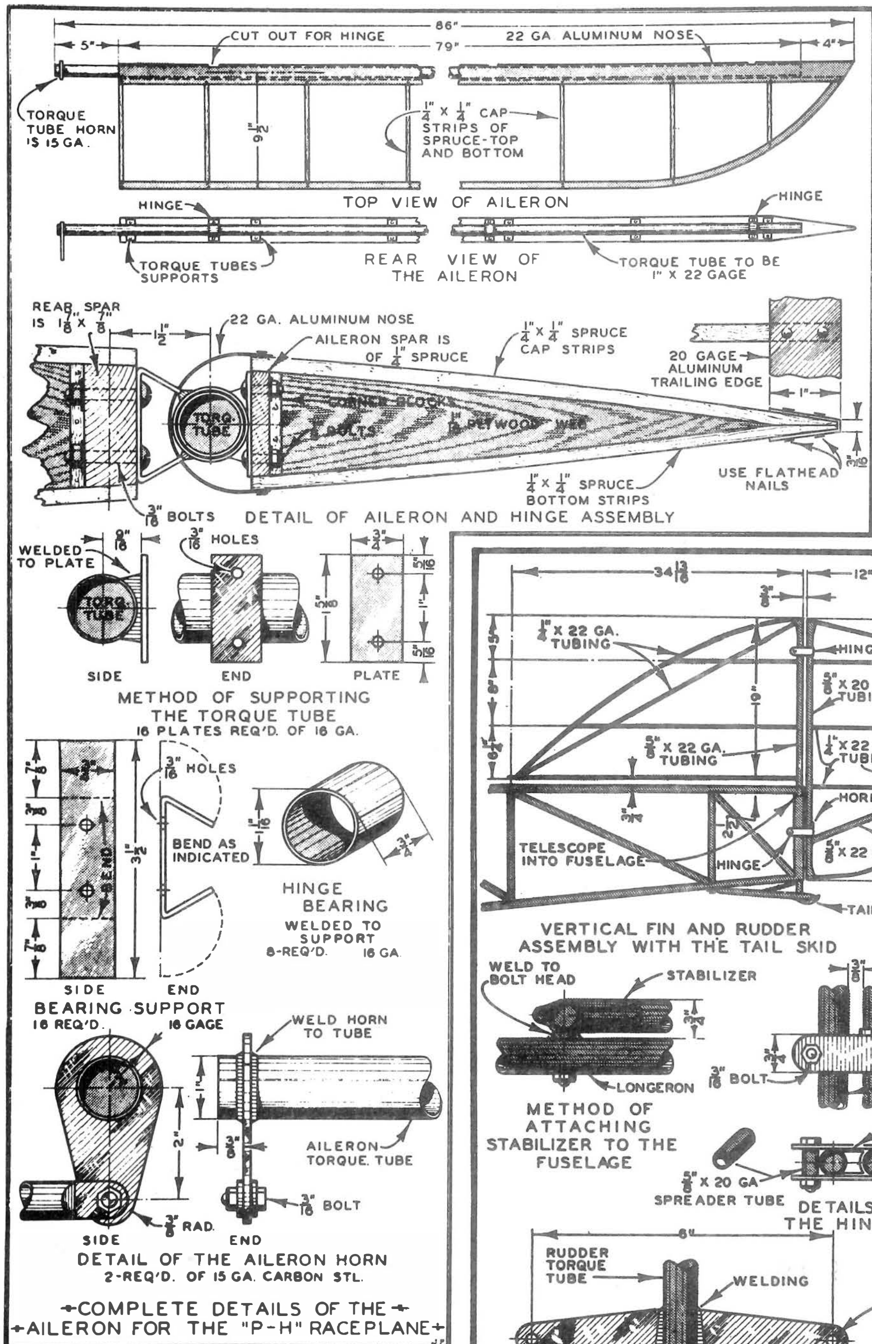


Figure 6. These detailed drawings of the aileron construction will make your work easy. Two inches are cut from the ribs.

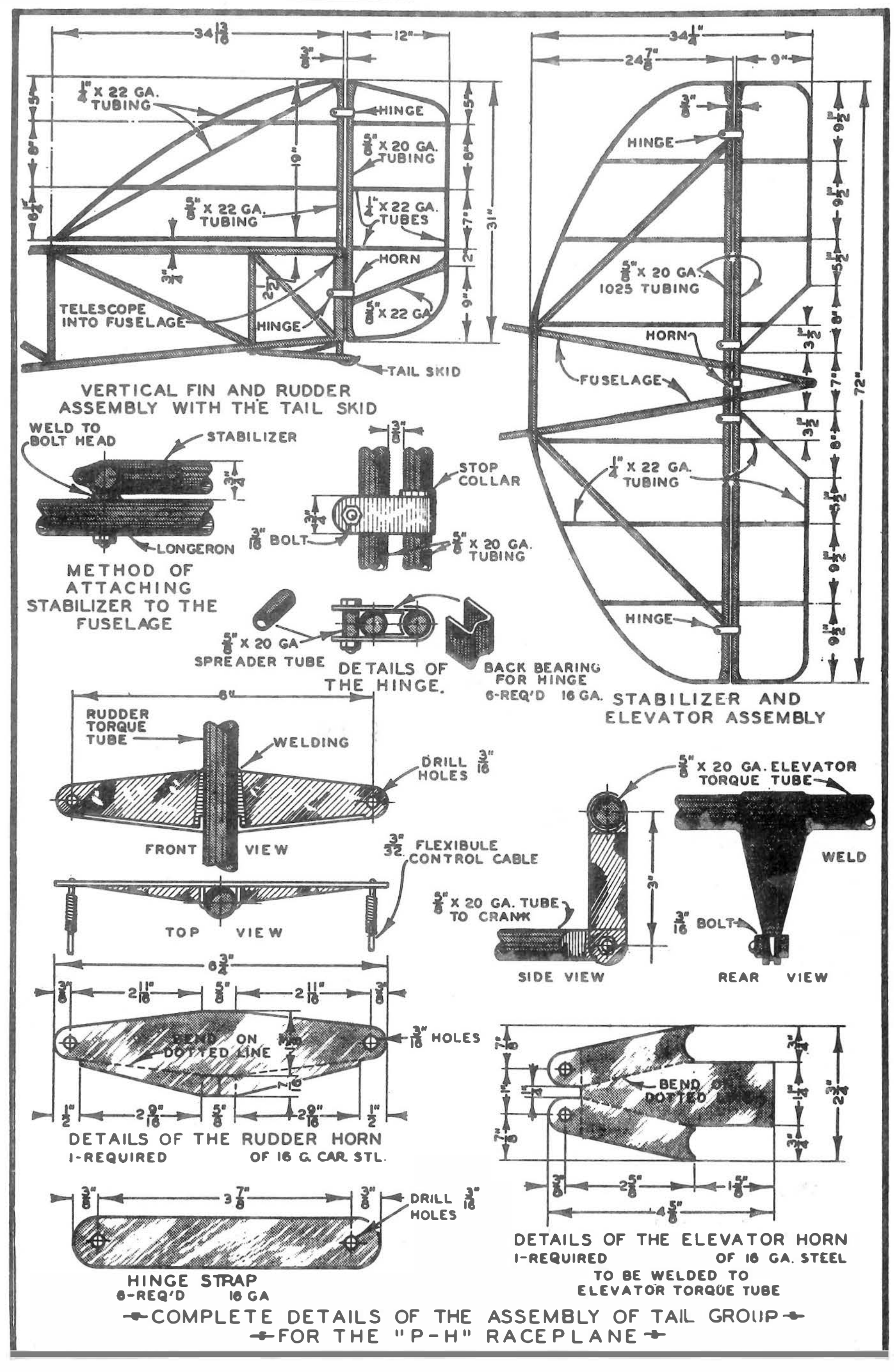


Fig. 5

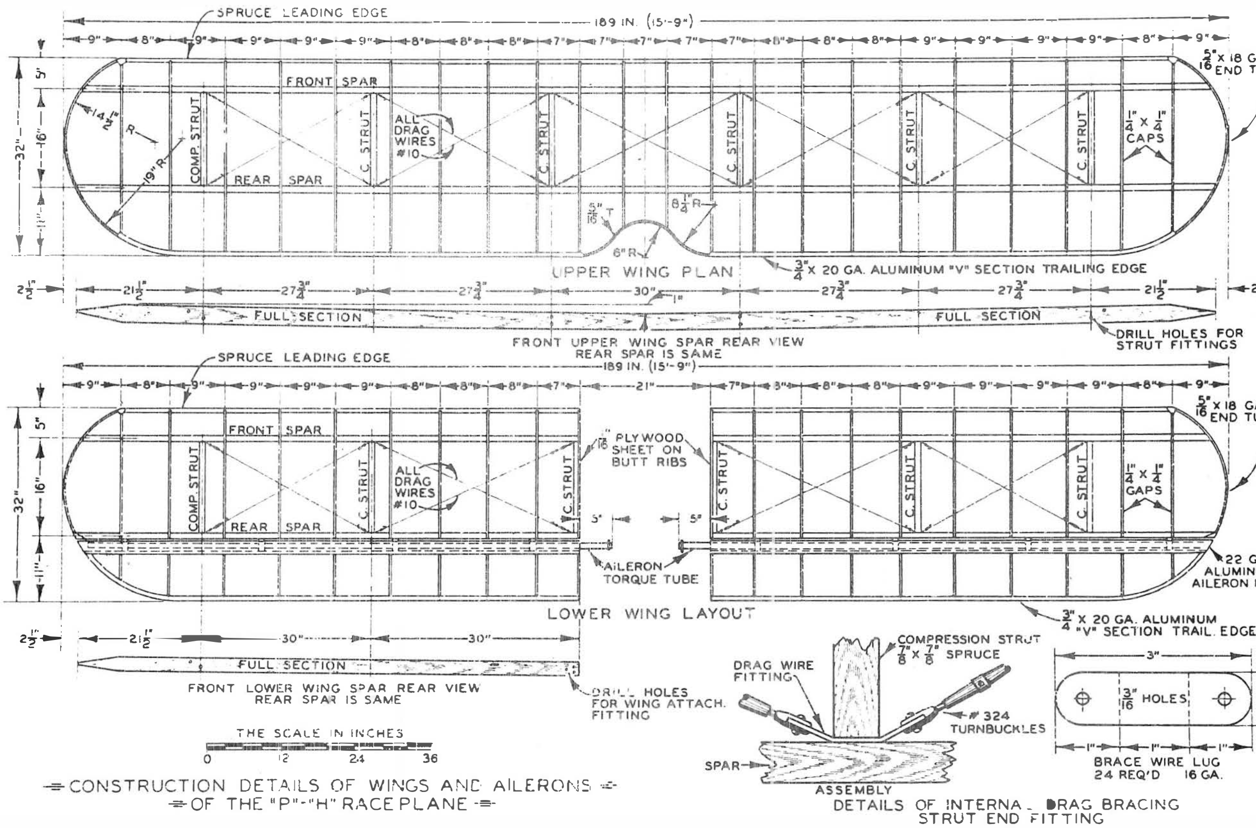
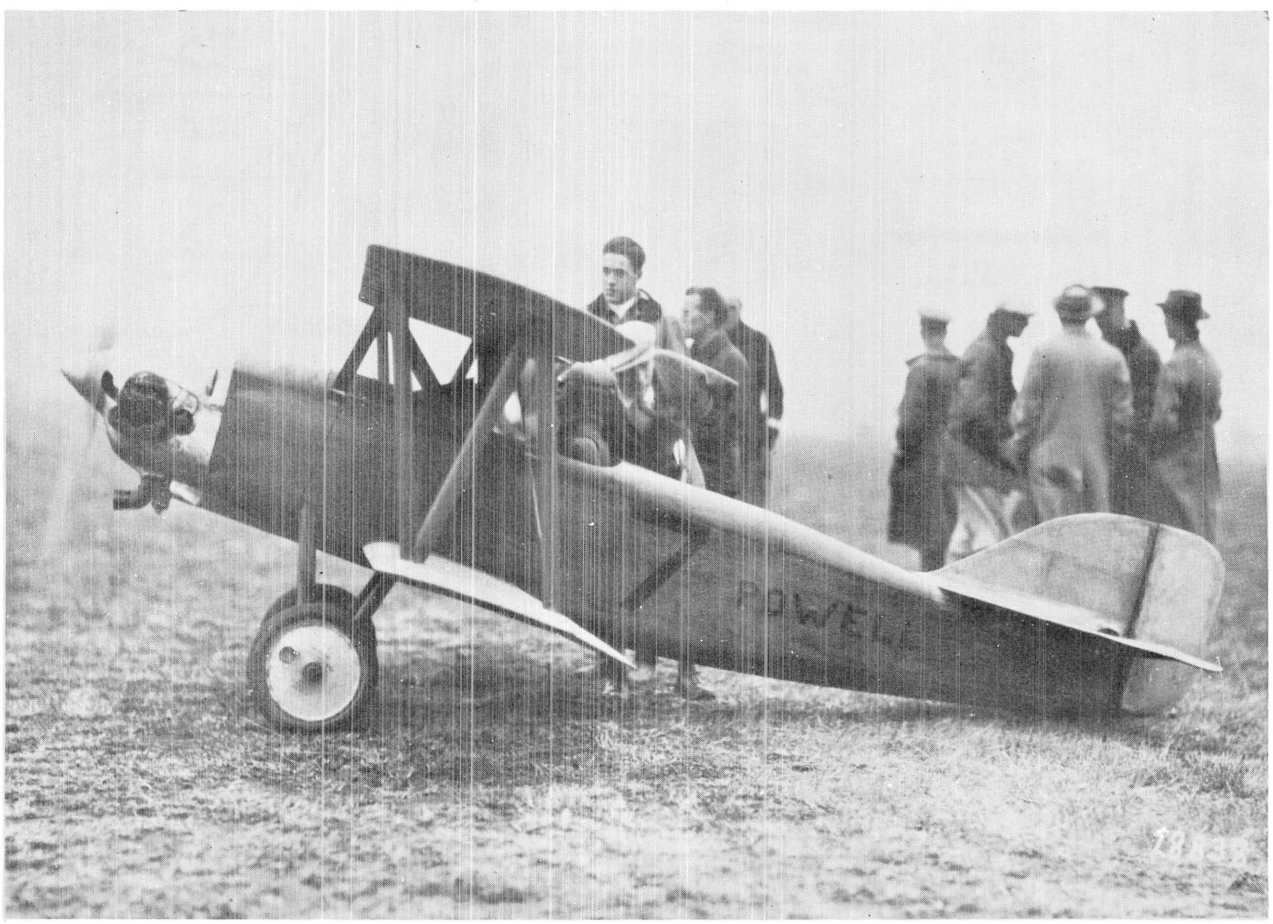
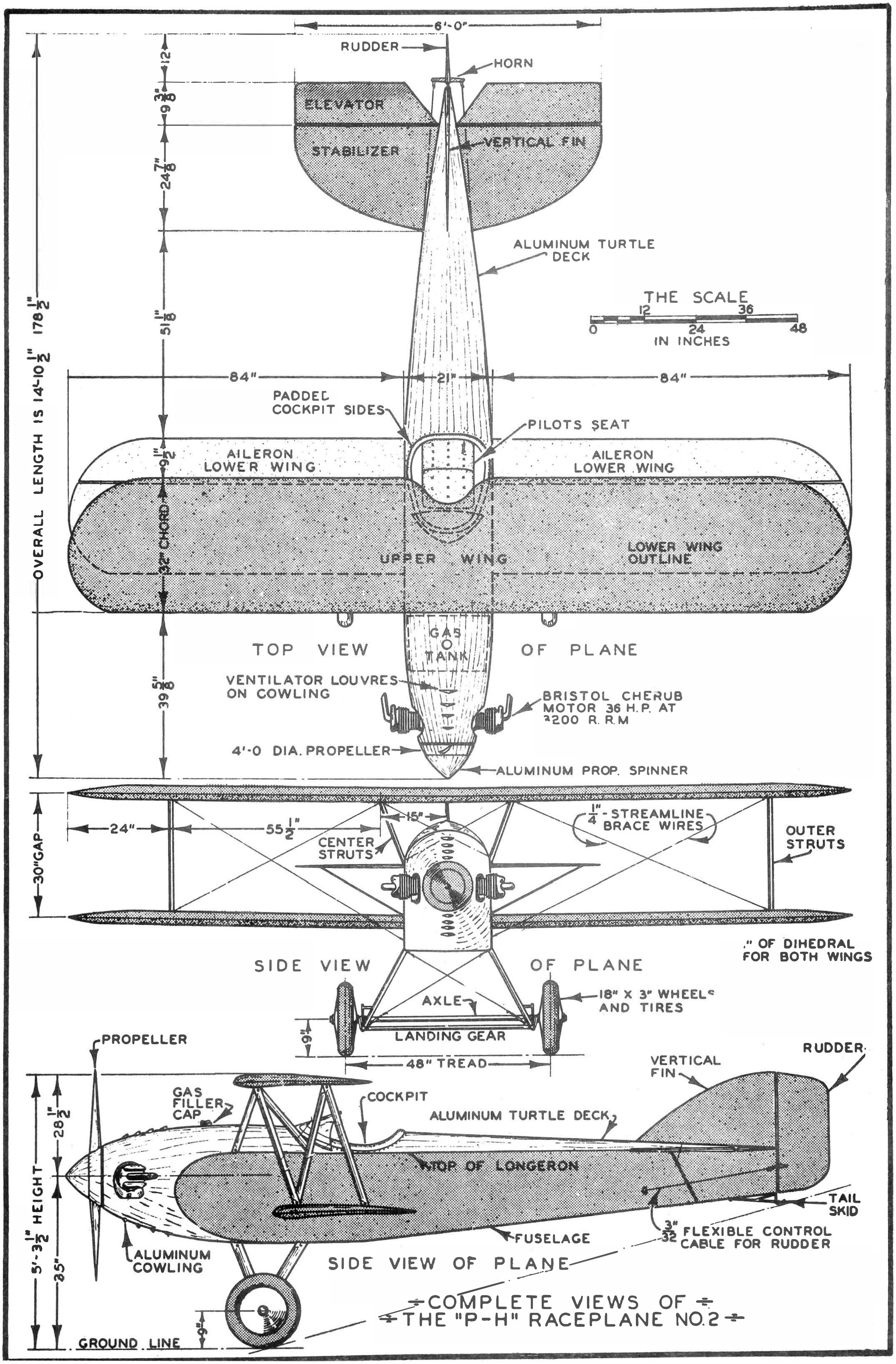


Figure 4. The wings are of simple, conventional construction. This drawing gives full dimensions.

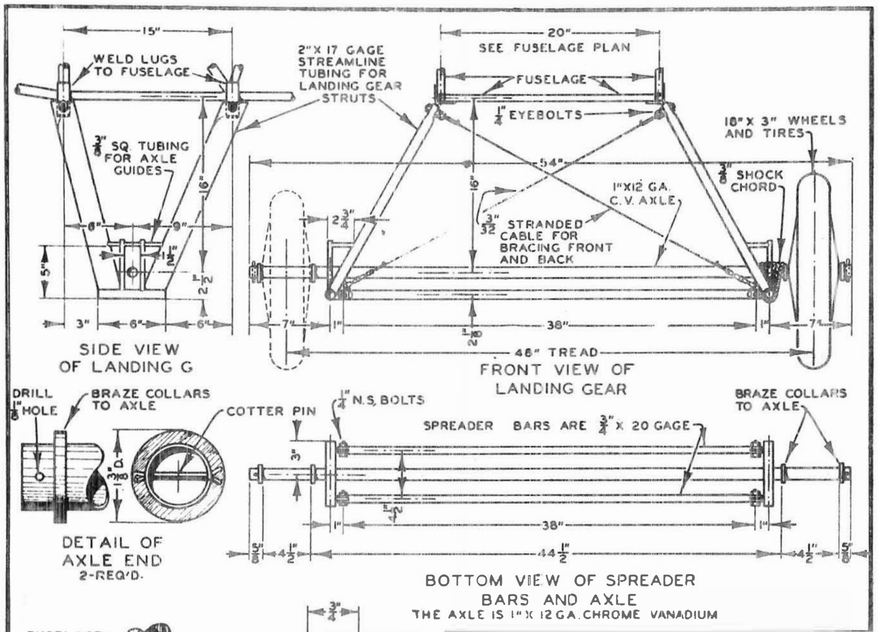


Powell racer at the 1925 Air Races held at Mitchell Field, N.Y. Air Force Photo from Jack McRae

Figure 3. This three view drawing of the Powell "P.H." Racer gives you some important dimensions.



COMPLETE VIEWS OF THE "P-H" RACEPLANE NO.2



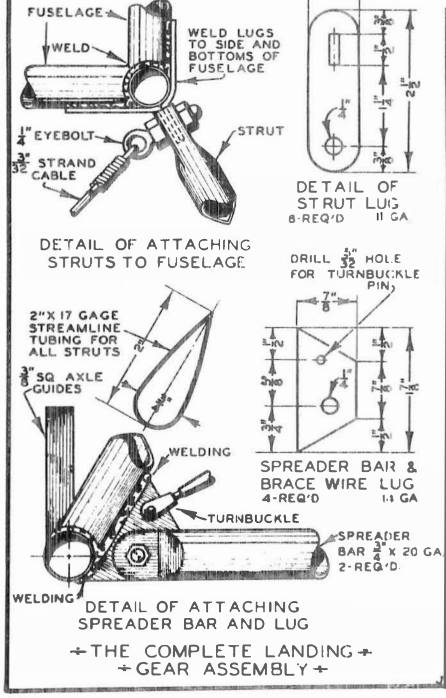


Figure 2. The landing gear is one of the most important parts of your plane and one of the hardest to build. Full details are shown here.

up as before, cut your diagonals and cross pieces and spot weld them. After making sure that your structure is still square you can cut and spot weld the internal diagonals, and will then be ready to weld the fuselage together.

This welding must be done by a man who thoroughly knows his job. If you don't feel competent to tackle this most important task you can hire a welder to come to your shop. An experienced man should be able to do all of the cutting and welding in two days at the most. Of course this will cost you more than if you did the job yourself, but if you have to make a forced landing (and who doesn't at one time or another?) it's a great satisfaction to know that your fuselage isn't going to come apart at some critical point. Welders demand good money for their labor, but it seems paltry beside what a doctor or undertaker can charge.

Start welding from the front end and go around the fuselage, working toward the tail. In this way you chase out all the kinks and warps that would develop if you went at the job in a hit and miss manner.

Now that you have the structure completed let us put on the lugs for the landing gear, center section struts, flying wires, and the tail group. These are all made of 13 gauge steel 3/4 in. wide and 1 in. long. They are put in their respective places and welded on (see Fig. 2). After all of these fittings are in place, the entire fuselage should be treated to a good coat of lionoil.

The motor mount is not given in detail, but is merely suggested in Fig. 9. The reason for this is that a mount suited for one motor will not fit another, and besides this, all of the boys have their own pet ideas as to just what a motor mount should be. The main thing is to get the weight of the motor in the right place. It is best to leave the motor mounting and cowling to the last, as the only practical way to attain perfect balance is move the motor an inch or so forward or backward as found necessary.

Empennage

Little difficulty will be experienced with the tail assembly after having built the fuselage, for the same procedure is followed. This job will also require welding, so if you have called in a welder you might just as well let him go ahead with these details, which are fully given on Fig. 5. If you are tackling this job yourself, lay out the fin, rudder, stabilizer and elevators on a flat table and outline in nails. Then cut the pieces to fit the forms and weld. Be sure to make the hinges and put them on the torque tube as you go along, for they are rather hard to put on afterwards. After all of the tail group is finished, check and see that it fits the fuselage, for you may have to make a few minor alterations, and it will be found much easier to have them done now than later when the parts are covered.

The Landing Gear

The landing gear is one of the most important parts of the ship and one of the hardest to build. It must be built well to stand the strains of landing.

Lay out the "V" struts on some flat surface, cut your 2 in. by 17 gauge steel tubing to the proper size, spot weld as shown in Fig. 2, then shape the tops of the struts and fit them to the fuselage lugs which are already in place, secure with 1/4 in. eyebolts, and weld according to the drawing.

Spreader bars of 3/4 by 20 gauge steel are then measured, slotted in the ends, welded up, and a hole bored for bolting to the spreader bar and brace wire lug which is welded to the struts as shown in the detail drawings on Fig. 2. The 3/8 in. square tubing axle guides are then cut and welded in place.

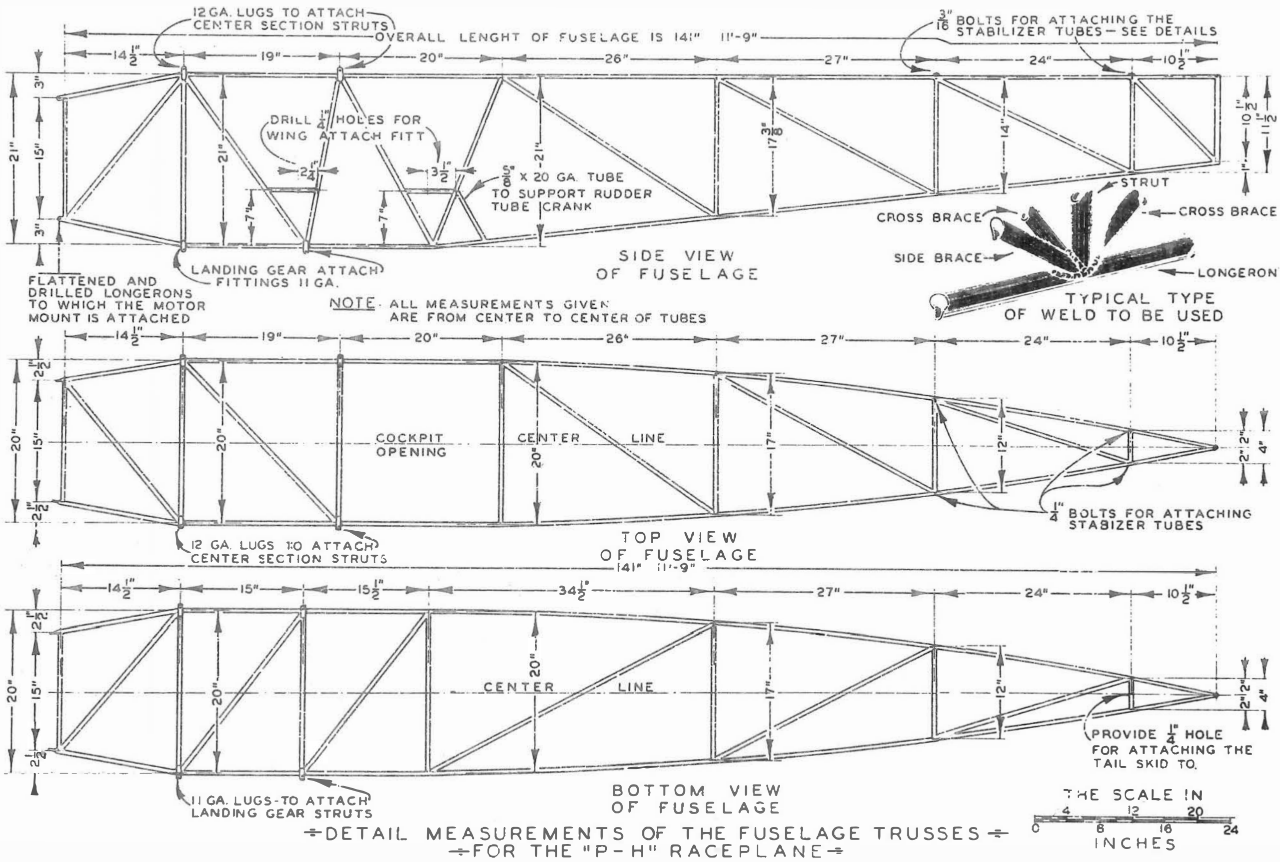


Figure 1. The lines for your fuselage should be laid out on a level surface from these drawings.

formance.

You will notice that nothing has been said of converted automobile or twin motorcycle engines. Such motors are absolutely unfitted for powering the "P.H." Racer, the former having too much weight and the latter not enough horses.

Now that I have scared off those who hoped to build something cheap from a few odds and ends picked up here and there, we fellows who have the price and want to build a real racer will step over to the corner of the hangar and take up the matter of construction. Let us start with the fuselage.

This structure is all steel and is of conventional design. Twenty-gauge steel tubing, commonly listed as .035 thickness is used throughout, the longerons being 5/8 in. material, while all other members are of 1/2 in. diameter except where otherwise specified on the plans.

The first thing to do is to lay out your plan on some absolutely level surface such as a wooden floor or a long table. When you are sure that everything is right to the fraction of an inch, take two pieces of tubing that are long enough for the entire length of the fuselage and outline them over your layout with nails so that they are right over the lines for the longerons.

Now you are ready for the vertical members and diagonals. The tubes should be cut with a hacksaw so that all are in place right to the dot. When this is done, spot weld all of the fuselage side together. Now make the other side just like the first and spot weld it too.

We are now ready for the most particular job of the entire fuselage construction. Having satisfied yourself that your floor or table is perfectly level, lay out the top plan of the fuselage and cut these pieces to the proper size. Then using nails or some other sort of jig to hold the members in their proper places, place one side of the fuselage, with the top longeron down, in its proper place, forming it around the lines you have already laid down, using a square to get the side absolutely perpendicular to the floor or table. Now do the same with the other side and spot weld the cross pieces and diagonals in place. The jigs will hold the work while you are welding it.

Now lay out your bottom plan, invert the fuselage and square it

SPECIFICATIONS OF THE POWELL "P.H." RACER

Length Overall	14 ft. 1/2 in.
Height Overall	5 ft. 3 in.
Span, Upper Wing	15 ft. 9 in.
Span, Lower Wing	15 ft. 9 in.
Chord, Upper & Lower Wing	32 in.
Gap	30 in.
Stagger	9 1/2 in.
Airfoil	R.A.F. 15
Angle of Incidence, Upper and Lower	0
Dihedral, Upper and Lower	1 deg.
Span of Stabilizer	6 ft.
Maximum Speed (With 35 hp Bristol-Cherub Motor)	95 mph
Cruising Speed	80 mph
Landing Speed	32 mph
Ceiling	14,000 ft.

Powell racer powered with a Bristol Cherub engine. Air Force Photo from Jack McRae

HOW TO BUILD THE

POWELL "P-H" RACER

The editors have consistently endeavored to present plans of lightplanes which were easy to build and within the price range of the average amateur. Here, however, is a one-place sport plane, designed especially for the builder who is willing to spend more money for greater speed and higher ceiling.

By Orville Hickman

Lightplane designers and manufacturers have adhered so consistently to the high-wing monoplane that many persons have come to believe that lightplane and monoplane are synonymous. There are some fans, however, who have so insistently demanded a one-place biplane of steel fuselage construction that their plea could not be ignored.

In the Powell "P.H." Racer these fans will find a ship that will require skill in building and flying, a knowledge of welding, strict adherence to the plans as given, and a real honest-to-goodness aero engine. For one who can exercise enough self-control to follow plans to the letter, and who has the price of a good lightplane motor, this article will present something that will get out and step with the best of them. A high speed of 95 mph and an absolute ceiling of 14,000 feet can be attained with this little biplane if the builder will give the job the time and money needed on a ship such as this. Those who want to use a two-cylinder motorcycle engine, and who can't do a good job of welding, had better leave the "P.H." alone.

Before we tackle the actual building of the plane, let us look around and see what we can use for the power plant. Only one model of this racer has been built, and it was powered with a Bristol-Cherub motor. This is an excellent little engine for a racing job such as this, as it develops plenty of horsepower for its weight.

The "Cherub" is a British motor, and is distributed by the Aero Engines of Canada, Ltd., of Montreal. Two American motors have recently been developed which are just suited to such a job as this. These are the Aeronca motor, manufactured by the Aeronautical Corporation of America of Cincinnati, and the Continental A-40 made by the Continental Aircraft Engine Co. of Detroit, Mich. You will find the Heath Henderson motor a very fine little power plant if economy is what you are after, but the above mentioned higher priced engines will give you top per-

28 percent to 38 percent from the leading edge, going back as the angle of incidence decreases and as the speed increases.

The spars are carefully machined, carefully worked down to avoid splintering and raises which would be the first to show failure in event of undue stress.

The old method of building routed spars is practically obsolete nowadays, and spars of solid unrouted characteristics are usually used. The Waco spar is about 6 in. deep and is 1 in. thick, solid spruce.

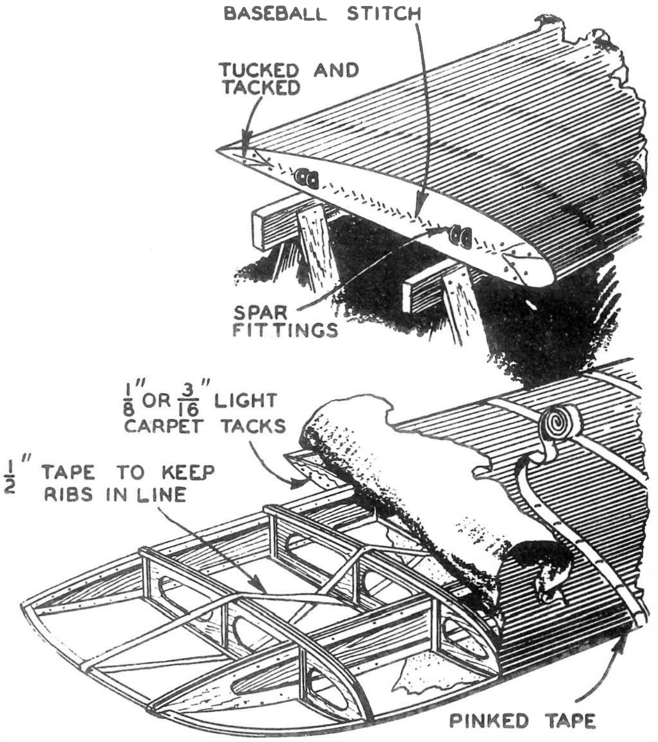
Of late some very good spars have been put into production using plywood, though if built as a web-spar the weight is apt to be greater than with a solid spruce spar. Plywood has been used for wing webs, too, with the usual light cap strip, and the one advantage they have is that they are stouter in a crash and can be built many at a time, being sawed out on the band saw to a template. Probably for the home builder the old reliable method of building up a Warren trussed rib using 1/4 in strips with plywood gusset plates is as good as any. This kind of rib is solid enough for any kind of ship in the lightplane class. As a matter of fact, theoretically the things could be a lot less in dimension and still be plenty strong enough, but the trouble for amateur construction then would lie in the fact that breakage would be apt to occur in the fastenings. Here is a case of practical consideration overruling the theoretical.

The accompanying drawing shows the method of building up a wooden template with a sawed-out rib jig box, and how the ribs are made by careful bending and nailing and glueing. This type of rib is easiest to repair while away on barnstorming tours. The cover can be ripped off and a small stick spliced in, and the cover doped over. Crush a plywood rib and it means rebuilding the wing.

Covering is an important part of the building of a wing, too. The old idea that linen must be used is not tenable any more. The majority of airplanes aside from factory jobs and the Army and Navy stuff are flying with a good stiff grade of muslin, doped. The reason, aside from strength, that the armed forces and the majority of factories use linen is that it is "chemically free" and does not deteriorate in several seasons' use.

The method of covering a wing after the spars and the ribs are on and the drag bracing is in place is to put a long slip of the cloth over the wing. This is sewed like a bag to the shape of the wing. It is best done on a sewing machine, using a double stitched seam. The lapping at the ends, as shown in the drawings, is pulled reasonably tight. Then the tape is put on and sewed through around the ribs with a long needle. Then the doping operation commences.

Dope is a chemical that stretches tightly when dry. The wing is put where no direct quick-drying sunlight can hit it, and a liberal thick coating of the dope is brushed in. When it is dry, and not before

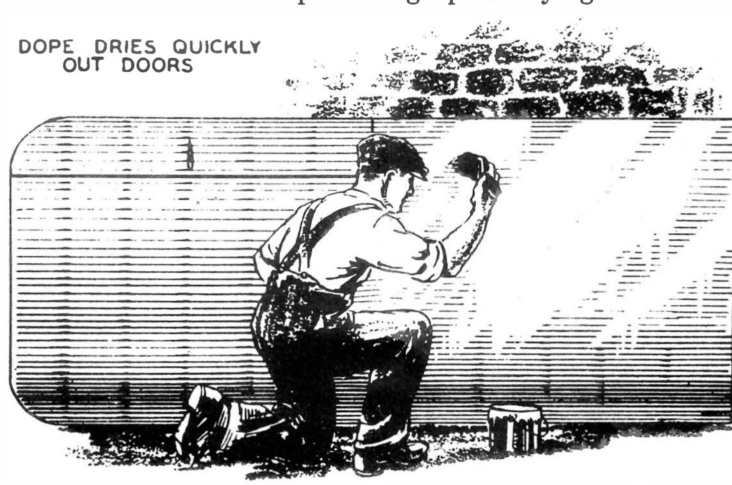


Covering is one of the most important elements in wing construction. This shows how the pillow slip covering is applied, and how the ribs are braced with doped tape.

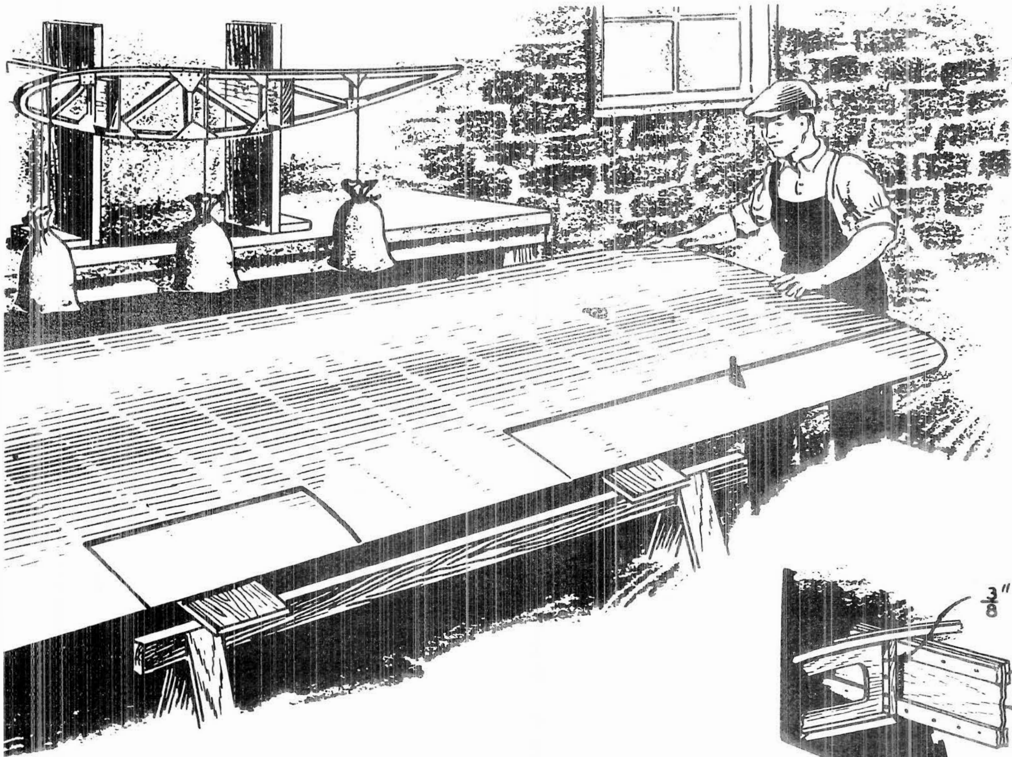
—that is when it loses its cool, damp feeling—another coat can be put on. Not before!

Then the next coat will see less sag in the cloth. It will begin to be drum tight about the end of the third coat, and one or two more coats can then be put on. Unless the wing is a very heavy one and very strong it is best not to put on more dope than that, as the dope has a tendency to bleed into the other coats, and when the whole skin starts its real drying the shrinking force on the wing is more than apt to warp it.

Pigment for any color can be mixed into the dope in the last two coats, and the wing is ready for rigging and ready for use in the greatest of mechanized outdoor sports—lightplane flying! • • •



Either flat or upright as shown, the doping should be done on a warm day, away from direct rays of sun. Dope dries taut after three coats.



ed seven to ten pounds per square foot will not fly well, if at all, in the lower powers. About 4 to $5\frac{1}{2}$ pounds per square foot is the best loading.

This loading is distributed over the wing surface and to the ship through the medium of the wing. In its peculiar construction each square foot of cloth throws the load it carries onto a rib or series of ribs. These ribs must be strong enough to throw the load onto the spars. The spars must be strong enough to absorb this load and transmit it through the struts to the ship proper.

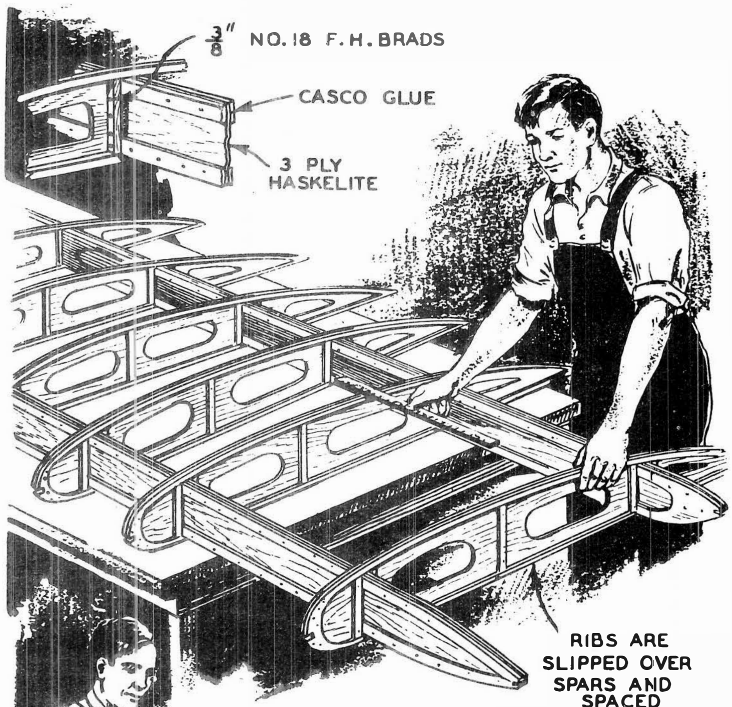
That is the design theory behind good wings. The building of the wings then starts in inverse order to the distribution of the load. The spars are built first, then the wing ribs, and the whole thing is trussed up with the drag bracing. Then the cloth slip is put over the wing, sewed on and the whole job is covered.

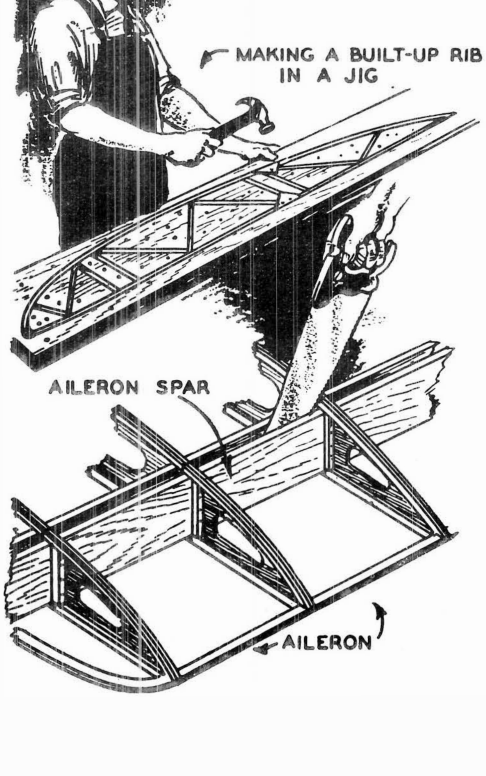
Spars in a lightplane are usually sized according to the load.

The Heath Parasol has four spars (two in each wing) which are roughly $\frac{3}{4}$ in. thick by 4 in. deep. This is sufficient on a span of about 25 feet to give a safety factor of ten to eleven on a load of not over five hundred pounds.

The greater the span the deeper and heavier must be the spars.

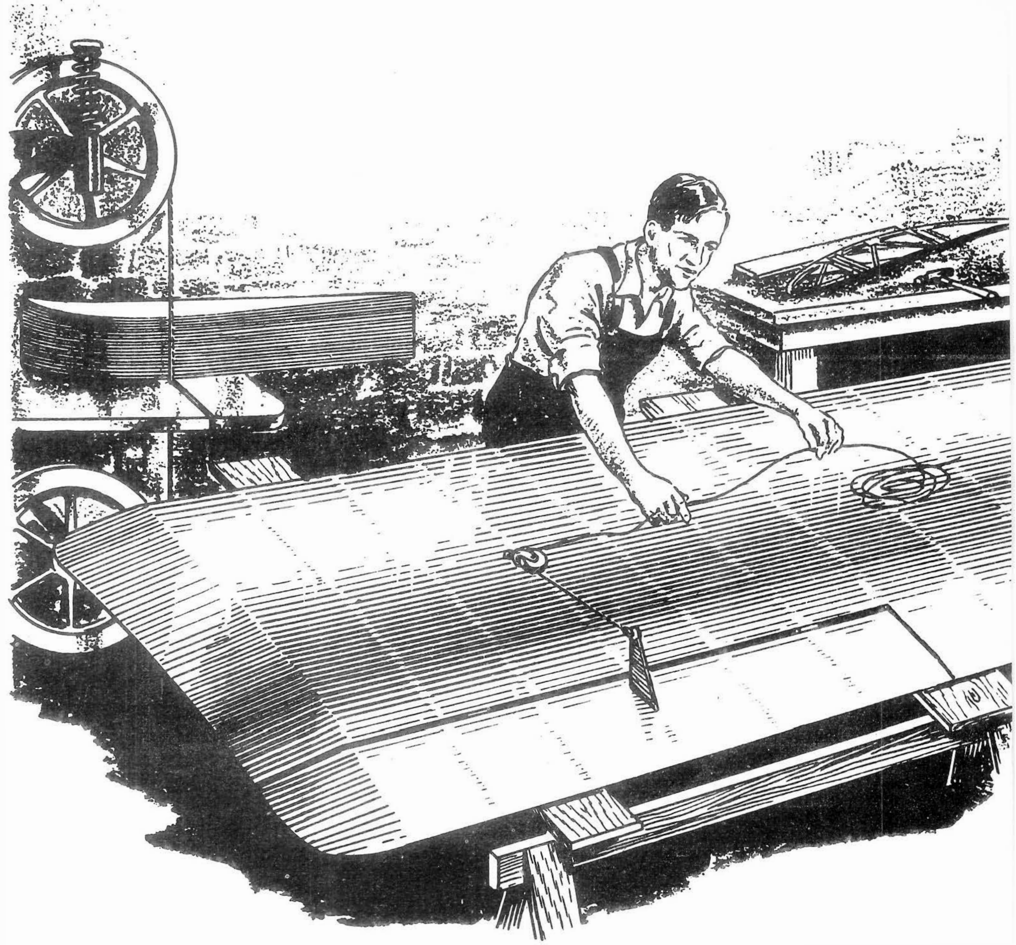
It all depends upon the design, and the reader is urged to follow the design carefully. If he is designing his own ship, he will be using some standard wing section, such as a Clark Y, which is pretty hard to beat, and if he places his spars at 15 percent and 65 percent from the leading edge of the wing he will distribute the load pretty evenly between the front and back spars. It is impracticable to get an exactly even loading on both spars. As a general rule the front spar will be carrying most of the load, about 60 percent, because the center of pressures of wings of standard sections are about





The method of stringing the ribs on the spars and of anchoring them with clips and No. 18 f. h. brads is clearly shown in this drawing. Template for strip type rib and method of "sawing aileron in" are graphically explained.

HOW TO BUILD GOOD WINGS



You can give the Flying Manual and its corps of light airplane writers full credit for the wave of lightplane popularity now sweeping the country.

Back in the spring of 1928, when we first began harping upon the advantages of the lightplane as a medium for getting Young America into the air, people thought we were crazy. Now the worm has turned and one has only to look to the activities of the airplane factories today to see whether the lightplane idea has caught on. Everybody is building, has built, or has seen one of these ubiquitous sky buggies.

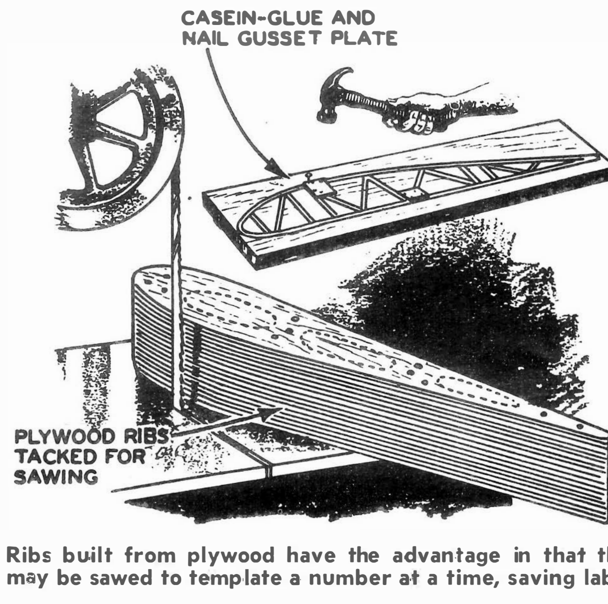
And for the uninitiated let us say right here that a lightplane is as different from an ordinary airplane as a goat is from a cow. Both types of ship will fly, just as both animals will give milk, and just as a goat is more light-footed than a cow so is a lightplane lighter to the touch, and easier to fly than a big ship.

Technically speaking, the difference lies in this fact: A light airplane can be made which will fly one or two men with low enough power and small enough dimensions to be airworthy. Then there is a point at which weights increase as power is increased so that the airplane is moored to the ground by weight and lack of power. Just the minute that one emerges from this class of design by putting more power into the ship, there sets up a need for carrying more weight in fuselage and wing spar so that by the time one has enough power the airplane weighs around ten hundred pounds and has about 60-70 hp or better. This is the difference between a lightplane and an airplane. The lightplane will fly well with one, (and in some instances two passengers) on low power and will have big ship flight characteristics. As the size increases the ship is weighted down by design factors until it becomes heavy and powerful enough to fly again. Then it is an airplane.

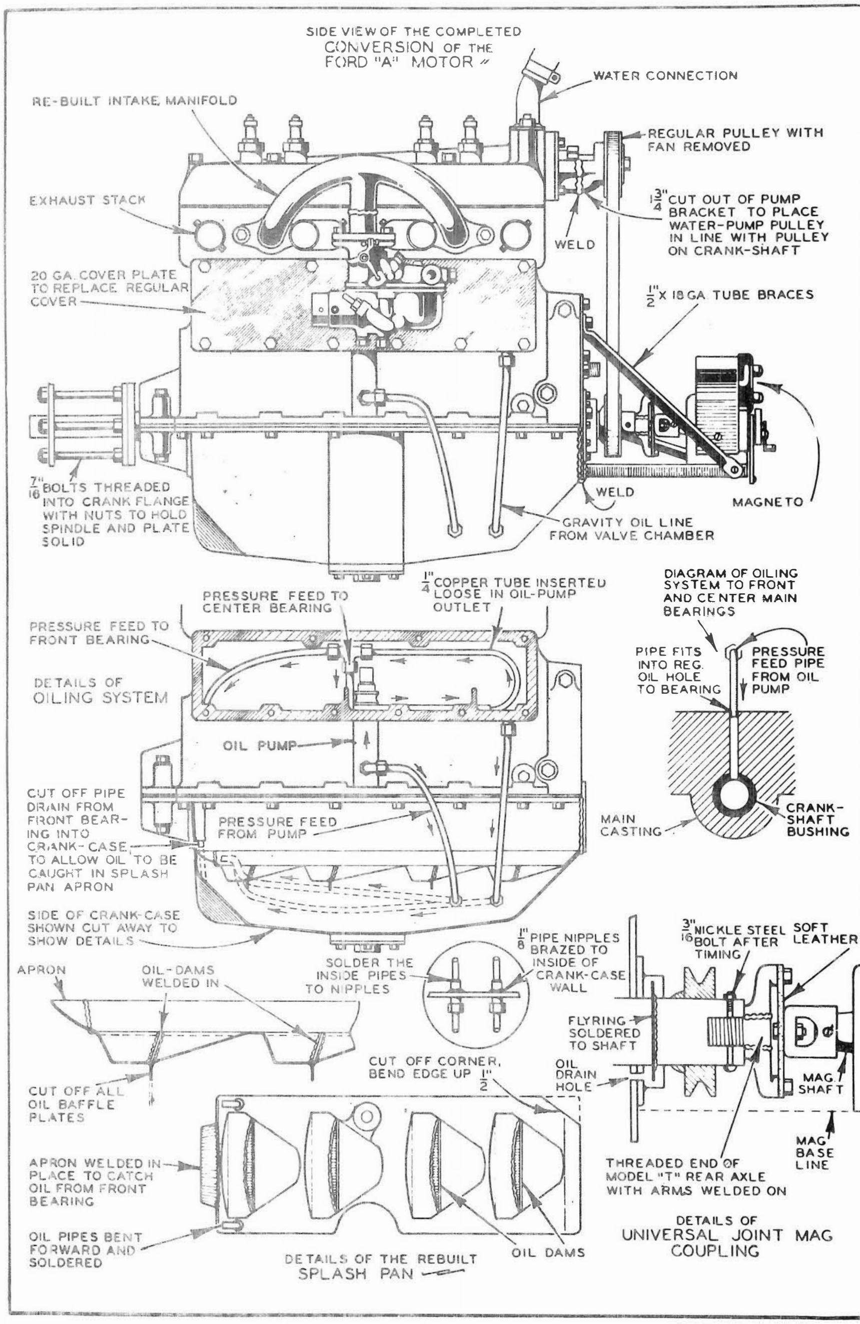
This lightplane fad we have sponsored is one that calls for skill in flying — nothing superhuman, but just good, careful flying.

And to do that it is important that not only the design factors of the little ship be in proper balance, but it is important that the wing area be right.

A ship loaded 3½ pounds to the square foot will handle a little like a kite. She will be light, and slow, and tender, but very controllable. A ship load-



Ribs built from plywood have the advantage in that they may be sawed to template a number at a time, saving labor.



Oiling system of Model A motor must be changed for use on airplane.

what little difference there is between this engine and the so-called converted one, which really is not converted at all — just "adapted."

I also append the power chart for the motor, which will show you airplane design fans what you can expect from the motor if you use it as I have here. If you want to design your own ship this curve will show you what power you can expect and what the revs will have to be. Note that at 1,600 revs there is plenty of "soup" left in the old gal yet. And there will have been very little falling off in torque at these rpm's. That is why I chose 1,600 as being the best revs to run the motor at.

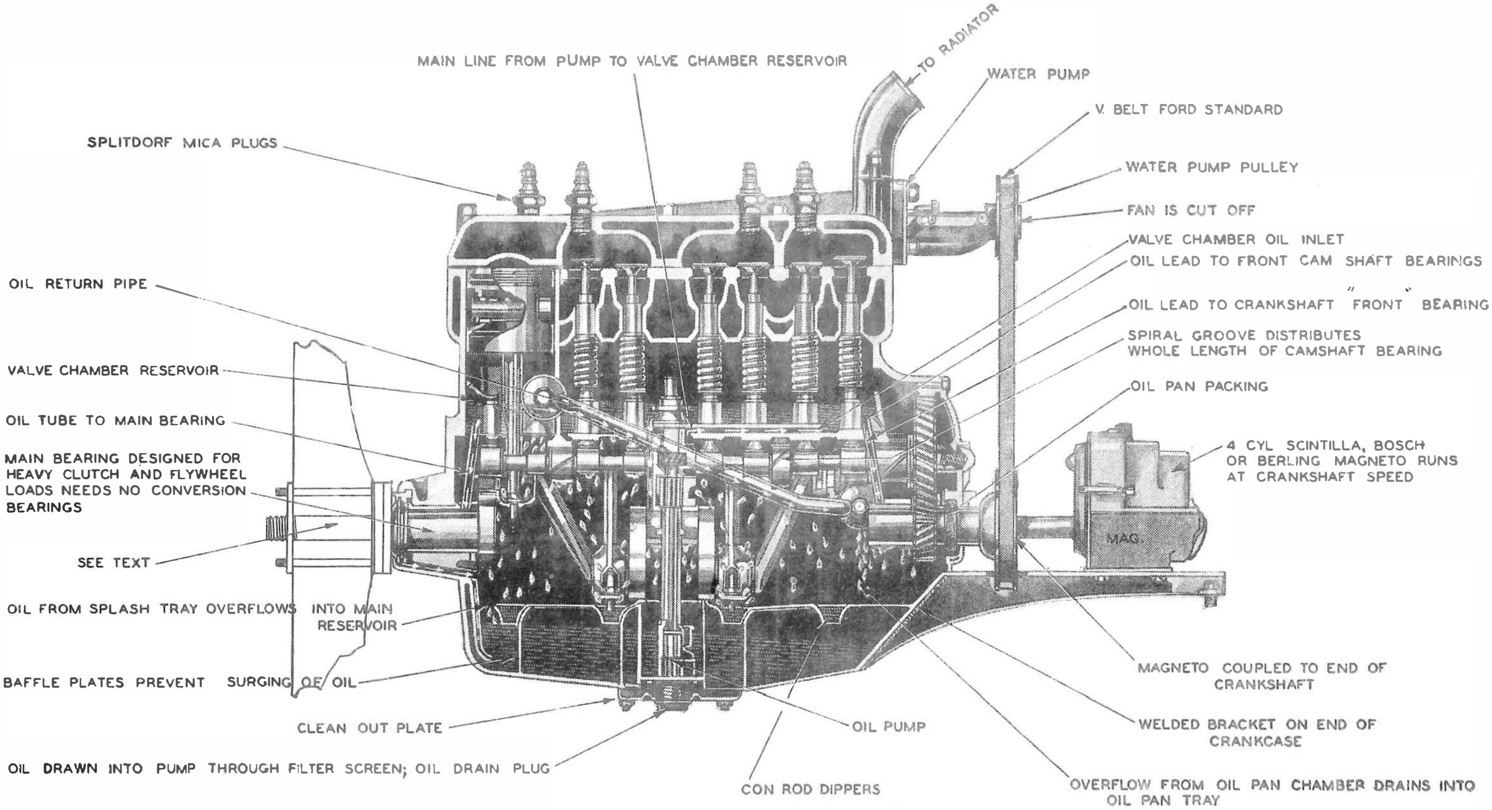
In use, treat the engine like you would any other airplane engine. Don't take off with a cold motor, and watch your mixture and your motor temperatures very closely. A remote temperature gauge should be used and the motor ought to be run between 140 and 160 deg. Fahrenheit.

And that just about covers all that need be said about the Pietenpol Motor Conversion, simple as it is.

You'll find the engine simple and dependable — one easy to repair, and capable of carrying you and your crate thousands of miles. • • •

The business end of Allen Rudolph's Air Camper.

Tomorrow's home-builder gives the Pietenpol a once over.



This is a sectional drawing of the Ford Model A engine as it is built for automobile use. The prop and the magneto mounting have been drawn in to show where they fit. Compare this illustration with other drawings in this article and you can visualize how little needs to be done to convert the Ford auto motor to airplane use. Designer Pietenpol recommends 1600 rpm as the best speed to run the motor; the engine develops about 35 hp at this rate.

the tach drive is fitted in.

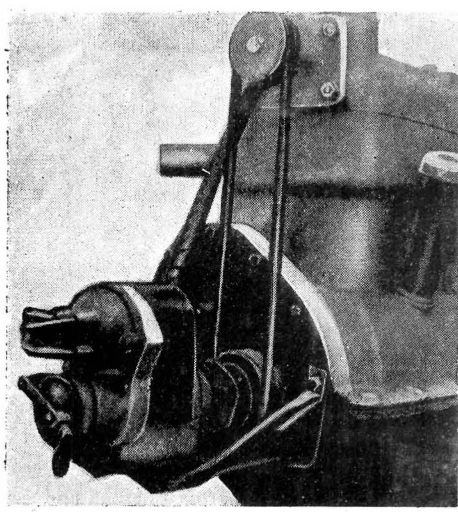
The dimensions for the exhaust stacks are shown in the drawing. They are made of 20 gauge tube and have tabs welded on them to keep them in place under the hold-down bolts.

Dimensions for the hub plates of 12 gauge cold rolled steel are shown in full.

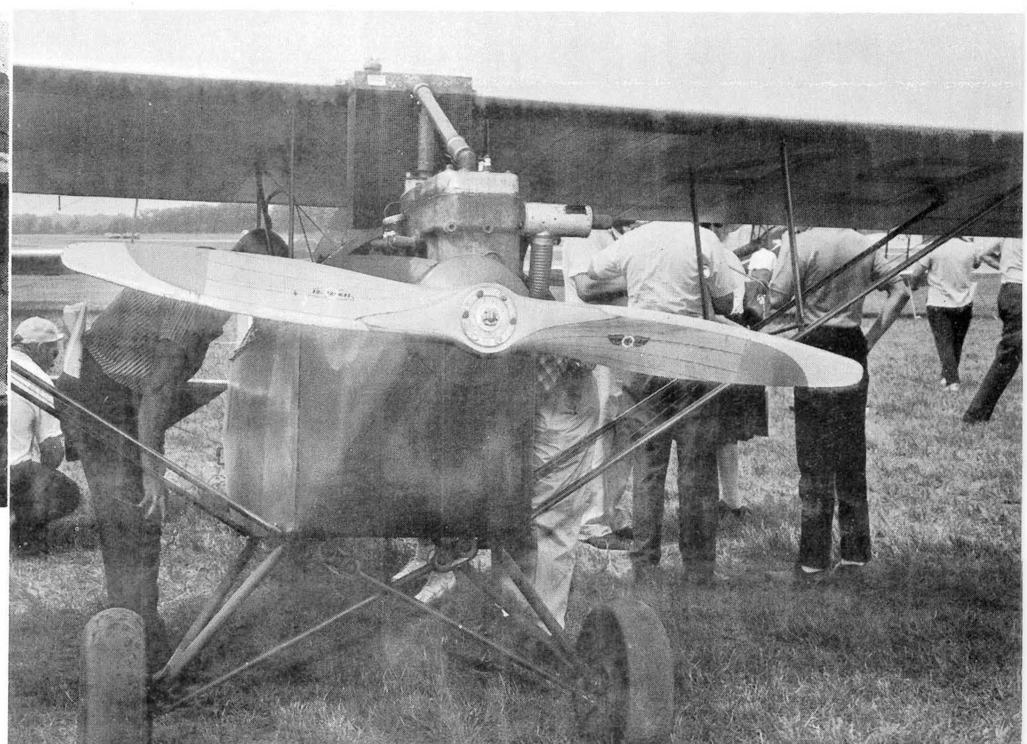
The oil intake pipe on the base will have to have a slight bend made in it to allow the water pipe to pass.

The radiator is a half section of a war surplus MF flying boat radiator. I can supply you with these if you cannot get them from any local supply house.

There is also being run with this article the full size cross sectional view of the Ford motor as it is used in an automobile. The parts used in the car are left in the drawing, with the exception of the magneto mounting, and the prop is shown in phantom drawing to prove to you how very little needs to be done to the Ford motor to make it an airplane engine. By comparing this drawing with the other two full page illustrations, you will be able to see



Here is the magneto installation, showing the special bracket welded and bolted to motor.



that they are perfectly satisfactory.

The method by which a fabric universal joint is built into the end of the crankshaft is shown in the drawings in diagramatic form. It can be altered to suit the magneto you use.

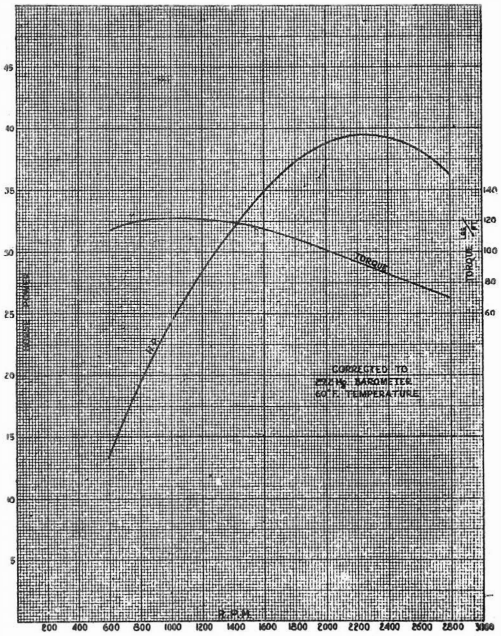
Also the bracket I show is made to fit the type of magneto we used. We found that the reliability of the magneto and the extra weight saved, together with the added ease in starting, was well worth the extra cost involved in getting a war surplus magneto and fitting it on. There is a snap to that old magneto spark that gives the motor extra heart when you have about 5,000 feet of alty and the road gets bumpy.

You will note that a light water outlet to the radiator is to be made. This can be made out of light sheet metal of about 20 gauge and should have an uptake long enough to allow a good hose clamp connection to be made.

With the oil system changed according to the drawings, which is an absurdly simple operation when you come to look at a Ford motor and realize how close it already is to being an airplane power plant, and with the magneto and the water and carburetor alterations made, there is very little left to do to make the motor a complete airplane plant except the fitting of stacks and the fitting of controls.

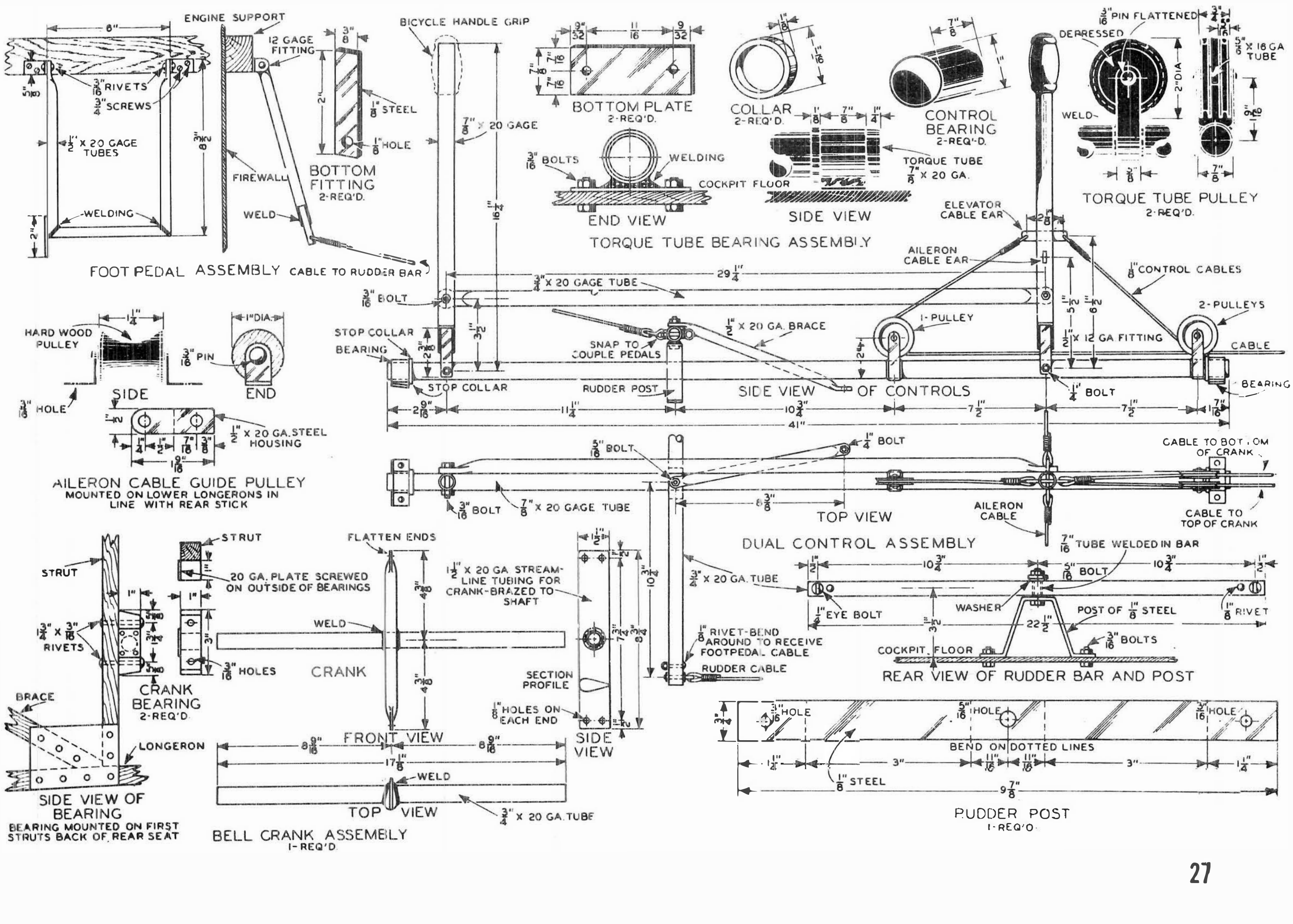
The end plates for the crankshaft and for the cam gears are very simple and are shown in complete detail. They are cut out of 16 or 18 gauge plates and their cutting and fabricating can be done from cardboard patterns made direct from the motor. The method of making the cup for the oil ring previously mentioned can plainly be seen also.

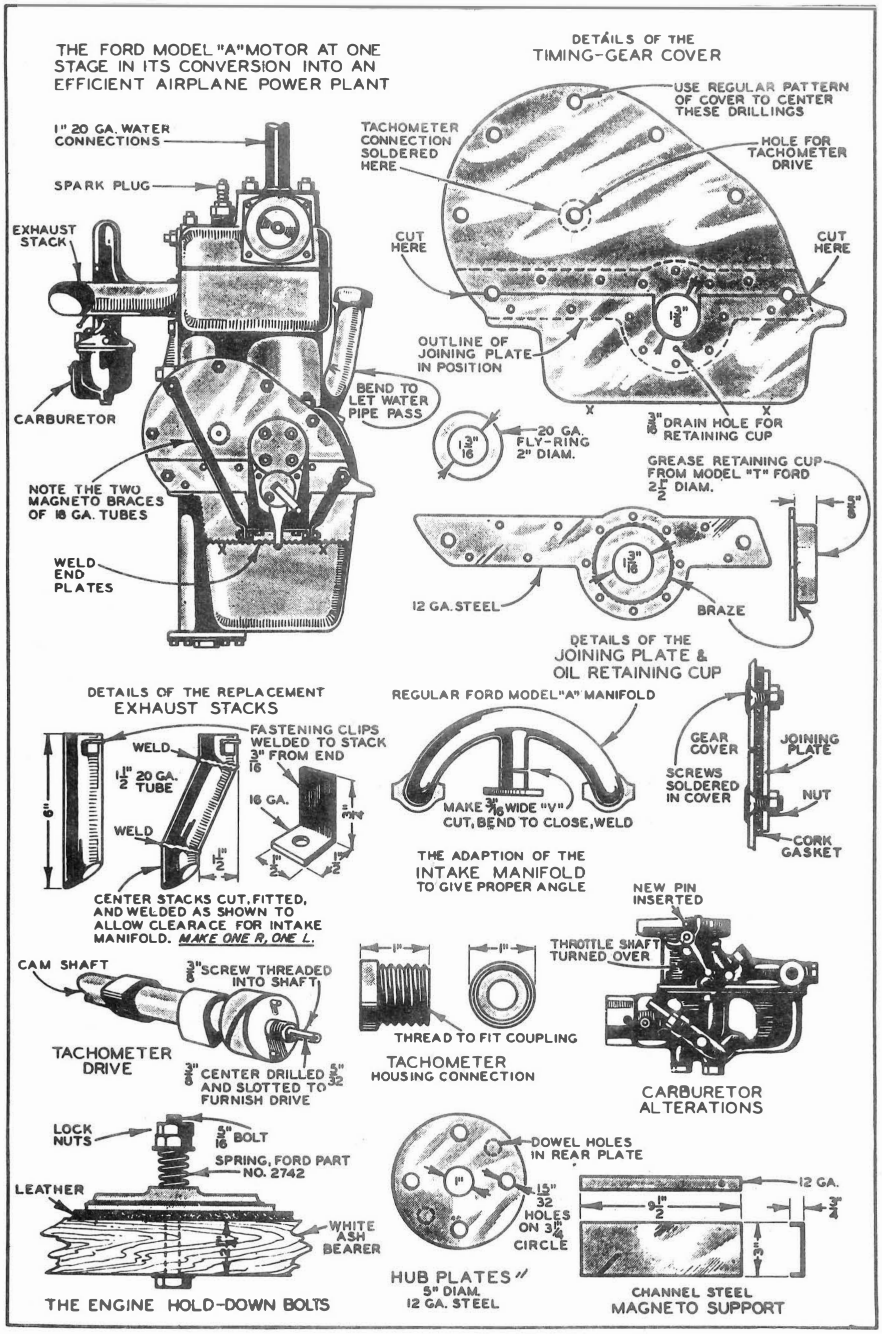
The method of making the tachometer fitting and putting it to the end of the camshaft is simple. A $3/8$ in. hole is drilled in the center of the camshaft and the 5/32 in. center-drilled rod for

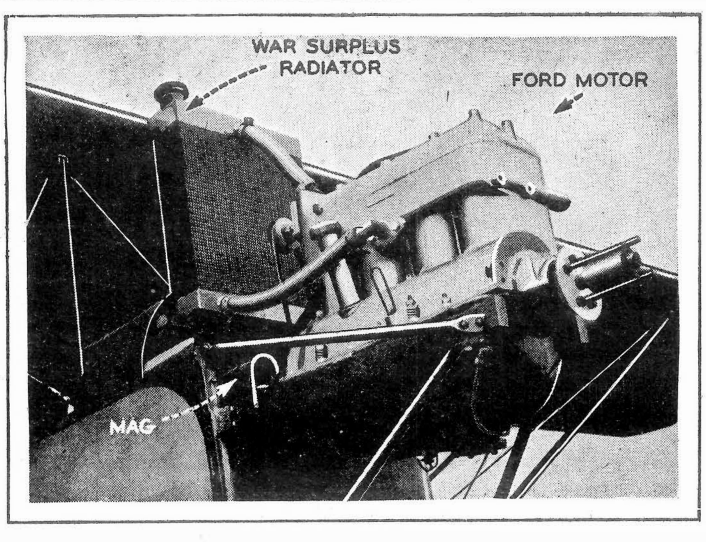


Graph of the power curve of the Ford Model A motor conversion; 1600 rpm's deliver 35 hp.

Here's the drawing showing all the details of the ship's control system.







The manner in which the Ford Model A engine is installed. No conversion is required—no thrust bearings. A mag is mounted on the end of the fan pulley.

feed they need if these are left out.

Off in the right hand corner a chip can be dog-eared off the corner of the pan to allow for the surplus to drip back into the lower base. The edge must be bent up ½ in. to allow a good reserve of oil to be carried in the splash.

The method of leading the pipes through the base is made very clear by the drawing, as it shows how the brass nipples are brazed into the crank wall and how the pipes are led from this point to the places where you want the oil to be delivered.

The regular cover plate of cast iron on the valve chamber is too heavy and you will have to make a 20 gauge plate to replace it. This saves several precious pounds of weight and is better looking as well as being tighter.

The intake manifold is rebuilt to be shorter. There is a tendency on the part of the intake to frost up, and the shorter you make the intake pipe the better performance you will have. Also there is need to get the carburetor outside and away from interference with the motor bed, so the change is imperative. By removing the carburetor, and the manifold, and sawing out a 3/16 in. slot in the back side of the neck, the carburetor is made to be level and is automatically made to clear the cowling.

Welded, the installation can be made and will prove highly serviceable. You see, I have found by experiment the amount of cut needed to get the carburetor level when the ship is flying level.

There is only one detail of the oiling system as yet left unexplained. That is the need for an oil ring to be soldered around the aft end of the crankshaft.

The drawing shows how this is put in. It is necessary to use this device to keep the motor from throwing oil all over the magneto, which would soon short.

The water pump must be shortened 1¾ in. to place the water pump pulley in line with the pulley on the crankshaft. The regular Ford pulley is used, and the regular Ford belt. We have found

THE PIETENPOL - FORD MOTOR CONVERSION

By B. H. Pietenpol

According to letters received by the editors, interest in the conversion of the Model A Ford motor as applied to my little ship has been mighty hot. I'm using Part IV of this series to give you the motor dope. Here it is — all of it.

The Ford motor makes an ideal power plant. It is rugged and very reliable. It is comparatively low speed, and can be serviced anywhere the ship may be forced down. And it is cheap enough to be easy to buy. The whole motor, brand new, costs but little more than a hundred bucks, and when converted as shown in this article will develop a good 38-40 hp, which is enough to fly two people in the Air Camper monoplane, the design of which I have just finished giving to you cloud hoppers in the first three parts of this article.

At the flywheel end of the motor you will note that there are no changes to be made. The flange to which the fly wheel fastens is left as is. Against it is fastened a length of Model T axle, the end of which goes into the differential. This is held in place with 7/16 in. bolts which are double fastened. By this I mean that the two flange faces are held together with nuts threaded onto the bolts, and that the ends of the 7/16 in. bolts are left to run out so as to be long enough to allow the retaining plate for the propeller to be placed over them and fastened and cotter-keyed on.

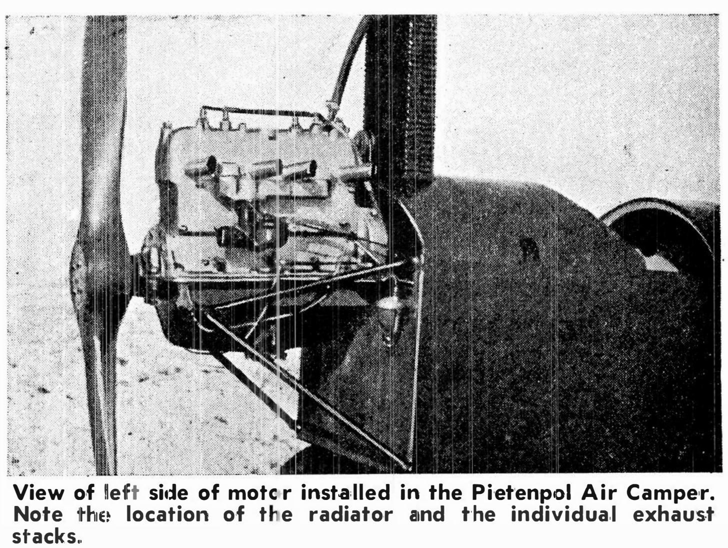
You will find the axle will not be thick enough to fill out the hub of the standard Lawrence 28 war surplus prop which is used with this motor, so a wood turned birch bushing will have to be made and fitted tightly over so that the propeller is on center. Then a 16 gauge retaining plate is made and the prop is on the motor for good. Yet it is readily demountable.

We have used this prop installation for a long time and it has yet to fail us. I believe it to be far more rugged than is necessary.

The crank case will have to have some work done on it to revamp the oiling system. A feed pipe from the oil pump will have to be let into the forward crankshaft bushing. The face of the crank web takes all the thrust, and since it is designed for all of the clutch and de-clutch loads of the husky Ford car, we have found that a thrust joint or bearing is a waste of time and money, as the bearing as it stands will thoroughly take care of all of the prop thrust loads. We ran one of our ships 240 hours and found slightly less than 1/64 in. wear at the bearing. Which proves that it will handle the comparatively light load very nicely.

The center bearing, you will note from the middle view on opposite page, is fed from the same oil pump take-off. To the right of the figure is shown the method of drilling the bearing casting and tapping the pipe into the journal.

The splash pan is rebuilt. You will find that a welded apron up front is needed. This catches the drip from the front bearing. Also the pressure line from the fuel pump is run forward and exhausted on the apron under No. 4 cylinder, which in the case of an airplane installation becomes No. 1 cylinder and will so be called in order from this point on. Cylinders Nos. 2, 3, 4 have oil dams built in the pan so that there is assured a supply of oil at all times. The ordinary indentations in the Ford pan allow the oil to travel toward the tail of the ship too fast, and the front crankpin bearings do not get the splash



View of left side of motor installed in the Pietenpol Air Camper. Note the location of the radiator and the individual exhaust stacks.

the motor has more than enough wallop to shoot two fellows into the clouds, the prop is turning at a slow speed, and is not effective until a certain measure of forward travel has been gained. To stall means that you lose the benefit of this forward speed, and that the ship falls off in pulling power for quite a while. If you don't have enough to get her off without a stall, go back and use the field over again.

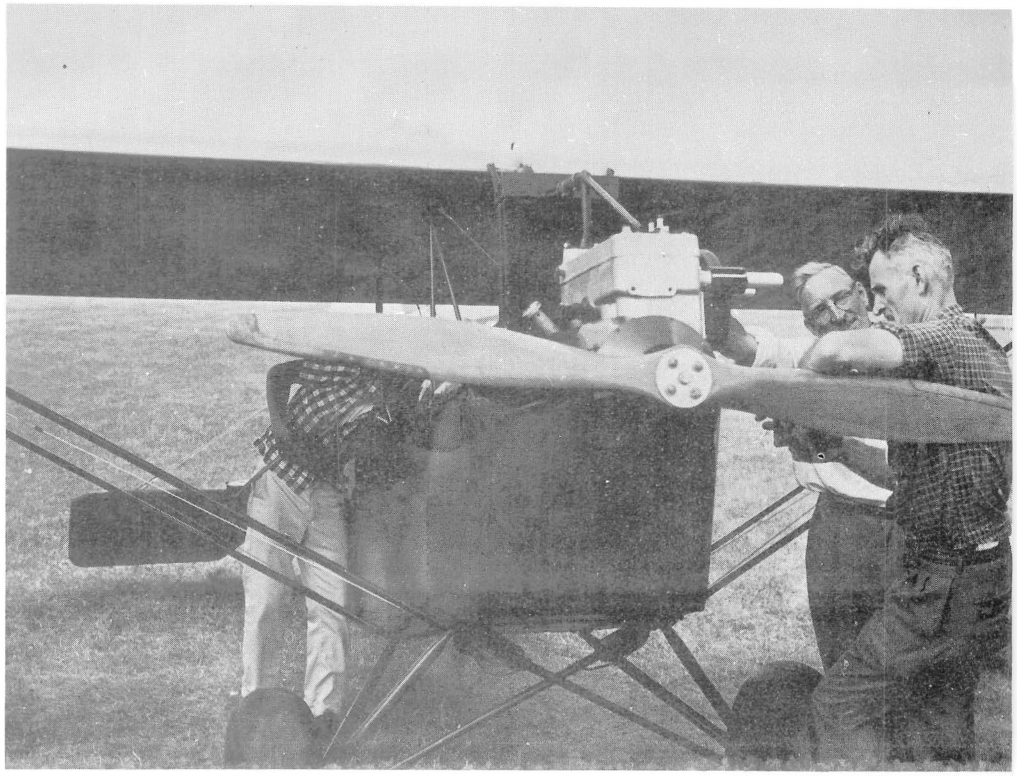
Once in the air, let the ship climb herself. If you have to, you can soup the stick back, and she'll jump amazingly, but you'll stretch the flying out of her quickly and she should be nosed down as soon as the lift is gone from the seat of your pants. She'll pick up fast enough. Then, on turns, you must not overbank. Try a few gentle ones first at better than 500 feet, and get wise to the pendulum action which all Parasol planes have. Try out the rudder and note how sensitive and ample it is for getting you out of any pickle.

Let go her stick gingerly and see whether her fore and aft control is good. If properly loaded and balanced the ship should fly hands off. She may need a little rigging though.

In setting her down, don't try any fancy right and left hand side slipping until you get the feel of her.

So there you are, Gang. The salient points of this little skybuster have been dealt with at large in my text, and the very good and complete drawings have made good the balance of the directions. The whole job is really so simplified that only the super-simp will want her changed. I'll build you ships with solariums, swimming pools or anything else you want, but after all the real experimenting and planning I have done on this ship I can't see fit to change a thing. For the motor we have used, ideal for everybody, she is about as hot as you'll ever find a plane, and I'll bet that 10 years from now the design will be pretty warm still. So build her as she stands. And don't ask me to change anything. The kitchenette airplanette for flying fieldettes is not yet, and I refuse to try to make the Air Camper anything but a good straightforward ship. The trick stuff is for other designs.

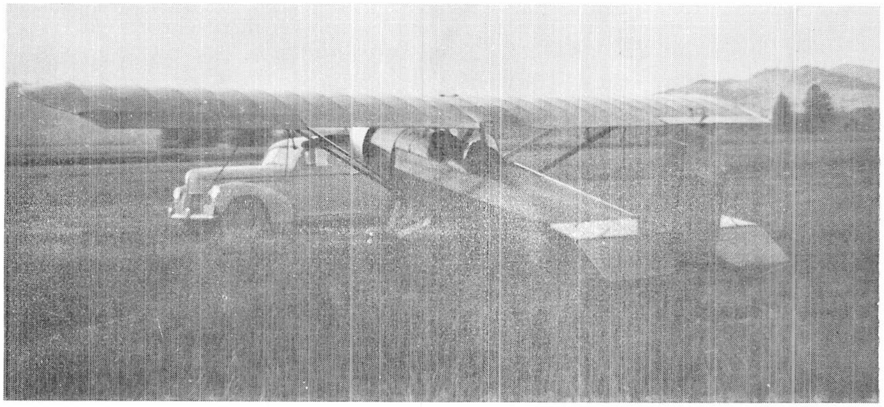
And before I sound off for the last time, let me tell you that the motor will be dealt with in Part IV. I am running a shot of the whole business end of the plane and this will serve to tie in with the drawing in Fig. 1C, so you can savvy how the job looks out on the tarmac with her bonnet off. She's a real treat. •••



The Model "A" swings a healthy size prop.

Jack McRae Photo

Model "A" powered Pietenpol built in 1935 by W. C. Harlin.



The Pietenpol Air Camper was one of the most popular designs of the 30's.

the ship is about 1/5 larger than a Parasol. Let's look at the empennage, or end spinach, next.

This as with all good airplanes and true, consists of a flipper set, a rudder, and horizontal and vertical stabilizers.

These are of very rugged construction.

As with the fuselage, each piece is built flat on the bench. There is a routed section at the fore edge of the vertical stabilizer which is rabbeted as deep as the 3/16 in. ribs. The curved parts are built of solid white pine faced and spliced to the routed section with plywood, casein glued. The drawings on both the rudder and the vertical fin are so clear that words are superfluous. The vertical fin is anchored to the fuselage with cold rolled steel clips. The hinges are of the same materials, and the hinge pins are clevis pins, long of about ⅛ in. diameter, cotter-keyed against sudden departure at critical moments. And while we are looking at the drawing showing the "end spinach" as the Hanagar Gang likes to call it, let's look at the ultra simple tail skid. Nothing but the fourth leaf of a Model T Ford front spring. Don't try to do the job of heating, bending and tempering yo'self, Andy, or you will sho' sho' have trouble. A plate running across the longerons inside the fuselage serves to complete the fastening system where the 5/16 in. bolt runs through. Or 2 5/16 in. bolts can be run through the longerons as the drawing detail shows in Fig. 4C.

Figure 5C shows the end view of the ship with the bracing system. The tail surfaces are covered with slips just as are the wings, and they are sewn and doped the same. Grade A muslin sacks of fairly close fits are made and then put on over the surfaces. Three coats of dope, well dried between, will be enough to carry the job along to the point where the drum tightness sets in, and so to the point when the ship gets her final coat of paint.

The flat plate of the horizontal stabilizer is made of rabbeted leading, side and trailing edges, with spruce cross members glued in with casein glue. Be sparing with the nails, and judicious with the use of glue, as with all other such joints, and the surface will last a long time. We have a ship which has been tethered out to the end of a hangar for a couple of seasons, and the surface is as stout as ever.

Be sure to test the surface for trueness in cross section after building, because nothing can be of more vexation than a warped stabilizer. This one is a flat plate and is not adjustable. It doesn't have to be, as the tail carries no load. It performs the "weathervane" function in the ship.

Maybe I had better give you fellows an idea of the way this little crate flies before I go into the motor details, because when I get there the space will be limited and crammed to the brim so that there will be no room for a say so on her flying qualities.

Presuming the ship to be completed, all the little details taken care of and the last coat of shiny paint dried and taut, the next thing to do is to pick out a field. And a pilot.

If you are a novice and have had less than 10 hours in the air, don't try to fly any new airplane.

If you do you'll come a cropper sure as thunder, and more particularly is it apt to happen with a lightplane like this, because you must remember one thing: You have to *fly* these light ships.

The idea of a novice getting into a ship and taking her off the ground the first time in the air is baloney. And it is all the more so if he built the ship himself as he'll just have to do the job over again. Not that such ships are dangerous — far from it. Structurally they are as strong as a church. But their power is not of the soupy variety that will drag pilot and ship behind it like a shirt tail no matter what the pilot does.

They take, invariably, a little longer run. And they are, invariably, more sensitive to rudder when on the ground. Particularly those of the Parasol type. So it takes a man who knows what it is to be able to fly by wishpower and what an airplane will and won't do.

No need to teach yourself to fly in this ship. You can always take dual, right in your own ship, you know. So—

Take the ship to a good field. And be reasonably sure that it is level. Bumpy fields, until you get the hang of the Ford motor, will make the motor spit on the ground and will confuse the pilot. Use all the field, and let the ship run until she has speed enough to fly herself off the ground if you have field enough. Never attempt to stall her off, because, while

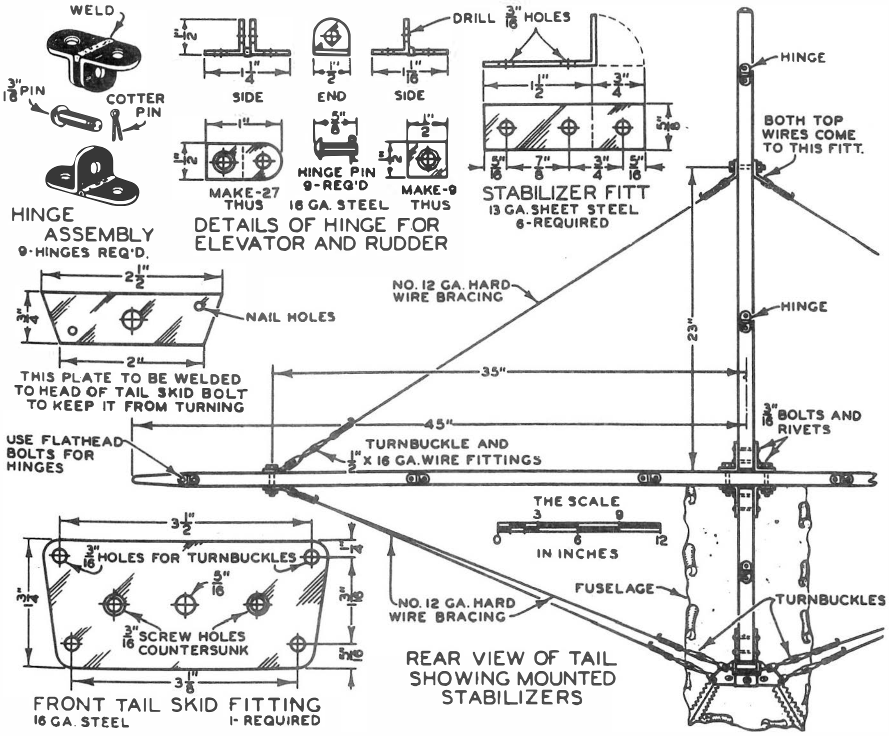


Fig. 5C. All the hinge details for the rudder and for the flippers are shown clearly. Clevis pins from turnbuckles are used for hinge pins. Grass does not affect take-offs, as tail is high enough.

this drawing and the cable pulleys are self evident in detail and need no explanation. The wheels of the pulleys themselves may be out of old Jenny pulleys. They should be of aluminum or of lignum vitae and are adapted to the strap fitting shown in the drawing, which is designed for the ship.

Now about those struts. They are of No. 2812 standard aeronautical streamline tubing. The length of the front struts is seven feet, six and a half inches. The front struts are shorter because the angle between the fuselage and the wing fitting is less. The rear struts are an inch longer.

The streamline 1667 tubing (obtainable at any good supply house, like Johnson of Dayton, Ohio) is used for center section struts.

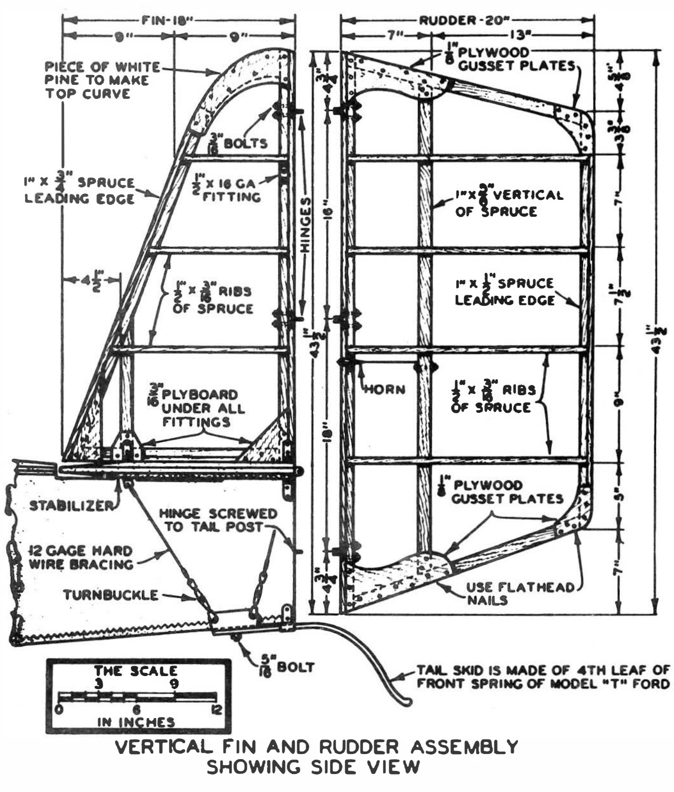
The wing struts have a 13 gauge anchorage which is of slightly peculiar construction. The loop of the 13 gauge stuff is made over a 3/16 in. by 1 in. tube which is afterward bored to 5/16 in. The 13 gauge stuff is best bent around a drill rod of the same outside diameter as the tube. The only way to get this bending done is to do it hot, and great care must be exercised not to overheat the metal, not to heat it too fast, and to allow it to cool to black before quenching.

After the tube is finally in, the drilling is done. The tube really serves as a center for the drill. The strut and the fitting are clamped together in a pinch with a small stout "C" clamp while the strut is being fitted to the wing, which has in the meantime been propped to the right angle of approach and incidence, and the hole for the 3/16 in. n.s. bolt is drilled. When this is in the lip of the strut tube around the strap is filled in with a weld and the strut is complete.

In lining up the center section strut system, all the guy wires are run criss-cross in the usual way, of 1/8 in. stranded cable, solder sweated into turnbuckles. One exception: The left side has no criss-cross wiring. This must be left out if you want to be able to get your flying mate into the office up for'ard. The right side is ample to take care of its 1/3 total of the load. So on the three sides of the center section, front left and rear sides as plainly shown in Fig. 1, in the first installment, there are the criss-cross wires. In this figure can also be seen the criss-cross stiffening system used on the wing struts. This is the system used on the Heath Parasol, than which there is no stouter ship flying as far as structural strength goes.

A good idea of the size of this plane can be had by a glance at this figure, too. It shows how

Fig. 6C. Here are the detailed complete dimensions for the vertical fin and rudder. Note construction of curved corners.



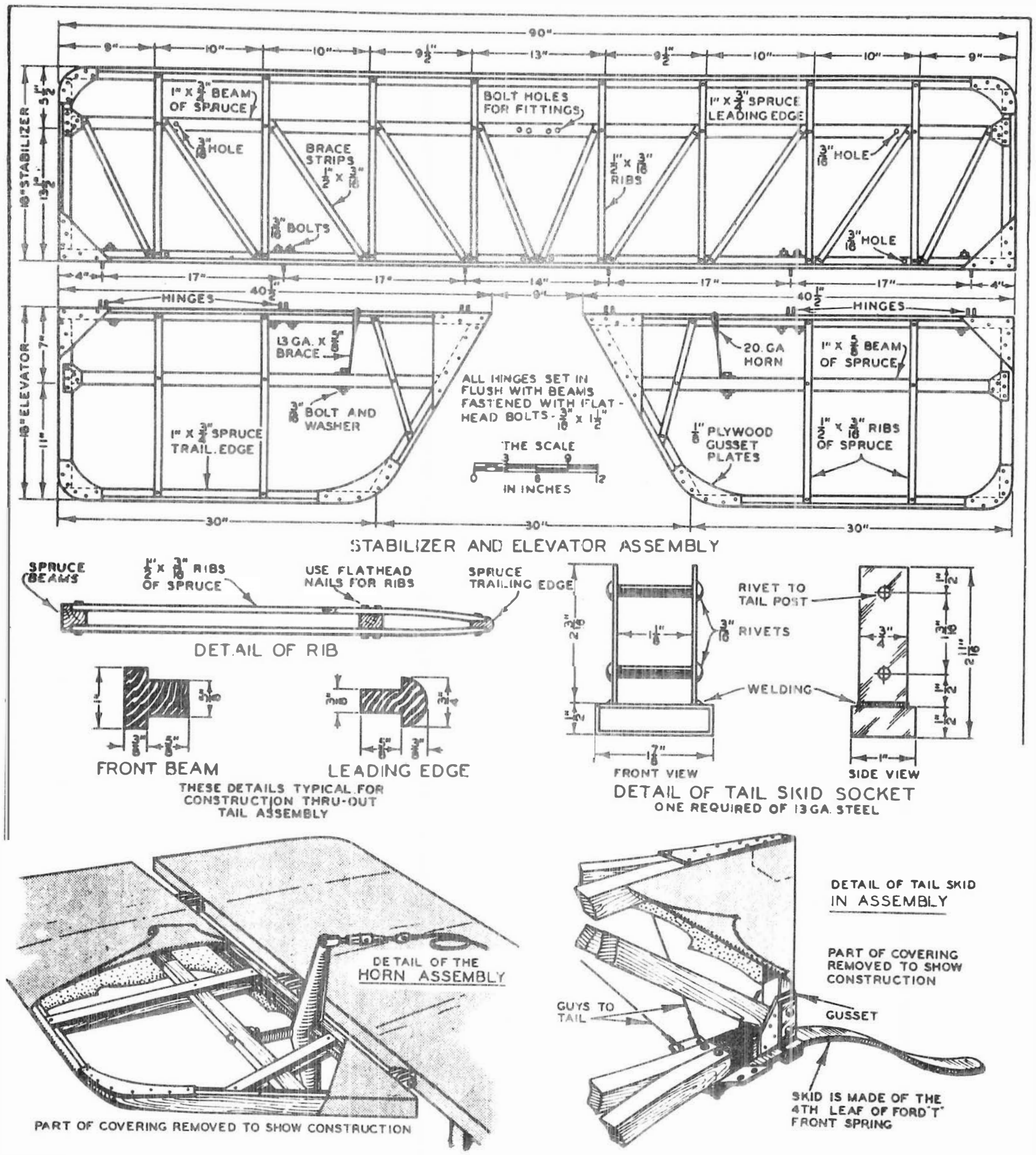


Fig. 4C. Horizontal stabilizer, flippers, and tail skid details are all clearly shown in this diagram.

are made of 13 gauge cold rolled steel, 1 in. wide and are 15 in. long in the unbent form.

The best way to work these into shape is to cut the blank, and then bend them to shape by gentle peening around a hardwood piece placed in a vise. Needless to say the piece must be of the same dimensions as the wing spar, as far as width is concerned, and it should be deeper so that after the fitting is bent the drilling can be marked out and the drilling done right through the wood to get the holes squarely in juxtaposition. (That last isn't a flyin' word, but as long as I get paid by the word, I thought I'd throw it in!)

You will note that there is a ¼ in. bolt of nickel steel running through the center of the fiting and that the bolt on the bottom side of the spar is 3/16 in. Further, the bolt on the strut attachment is a 5/16 in. size. These are of the correct strengths to use. I have heard some criticism of this fitting by those who said that the fitting set up an eccentric moment about the neutral axis of the wing spar. That may be. But I do know that the center bolt is the proper distance from the center section strut to go right through the neutral loading point. Any slight eccentricity is of no moment, to my way of thinking, to that super-spar that goes into the wings of these little sky wagons. An elaborate strap fitting with tentacles in all directions *might* be better. Have never had an opportunity to see as in all of the flying I have done, and in all of the flying done by the others who own these ships, there has never been a suggestion of off center loading, even in crack-ups.

The center section strut fittings are something I am very proud of. I have never seen anything like them, and consider them clever because of the fact that the hanging feature permits of a doubling of metal at a critical point without throwing too many bolts (always a danger point in plane construction) through the wing spar.

These too should be made on a wooden form, preferably of oak or of ash, drilled, and then welded at the fillets — just at the corners, to hold the under fittings, or strut pendant, rigid.

The aileron pulley bracket in

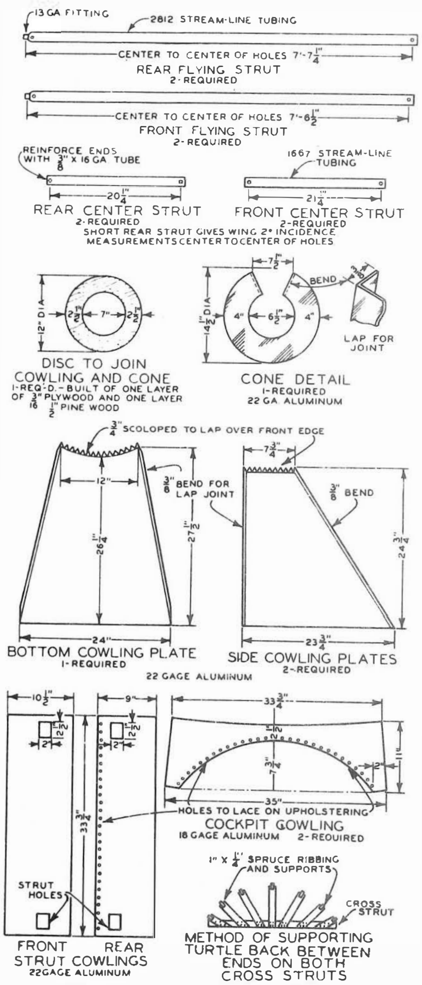


Fig. 2C. Strut dimensions and cowling details.

other 2 in. by 2¼ in. (to allow for the accommodation of the oil pump on the left side of the motor sump) are rested directly on the beam anchoring the fuselage bulkhead. One ¼ in. n.s. bolt, with washers, of course, is run through a drilled hole on the 1 in. piece. Two are used on the 2 in. piece. Virtually, then, the engine bearers amount to 1 in. net thickness, and are supported at their outer ends by an A frame of ⅞ in.—20 tube. This tube is heavy enough for engines up to sixty or seventy horsepower. In fact, we built one of the ships powered with a five-cylinder Velie of 60 hp and the ding-busted little wagon flew rings around itself. We never had a moment's trouble.

You note that the bolts on the ends of the A frames are sunk so that the bed of the motor does not interfere with the job.

The wood bearers are set in, bolted and lined up. The A frame is made on the flat, and with a saw cut just forward of the fitting, sawed far enough through to just allow you to bend the frame into position, the forward ends are lined up.

Then the frame is taken off and the v-shaped gap filled in with a good weld. The 16 gauge reinforcing plate at the apex of the A is, of course, welded in before the frame is finally put in. It may pay you to make a jig for this job, but I dinna know. It all depends on you, as the radio singers say.

I can hear faint remonstrating voices concerning those fittings which are used to anchor the A frame. Particularly with reference to the bottom fittings where the anchorage for the A frame is jogged up so as to give a slightly eccentric moment at the point. Don't change it. I have never had a moment's trouble with this design, and the jog is necessary to allow the cowling to go over the snoot of the ship so that a clean job of fairing results. Otherwise there will be a bib on the bottom of the cowl which will not only not be clean looking, but which will whistle like a sour owl when the ship is in the air. I never did like to fly fire sirens.

The fittings are very simple. All details are shown in the plans. And they carry back far enough, to my way of thinking, into the longeron. They carry just enough bolts to carry the load on through, and not enough to weaken the grain of the wood. In several pancakes and a mild spin which we have experienced with the ships sent out to other hands, the motor fittings never gave way in a bust up.

The patterns for the cowling are shown in Figure 2C. This stuff is made of 18 and 22 gauge aluminum. The lighter gauge is indicated by the higher number, as you know. The lighter stuff is used for the front and rear strut cowlings and on the under motor cowling. There is no top cowling to the motor, and the cowling to the turtleback is made of the 18 gauge stuff. Note that there are holes drilled in it to take the very necessary padding lacing which must be used around the cockpit to keep a fellow out of serious arguments with the skin of his face and hands.

The fittings for the strut attachments and the metal work involved call for a dissertation. By a reference to Fig. 3C one may see the outer strut fittings, the center strut fittings, and the other strap work which goes into the wings.

The outer strut attachments

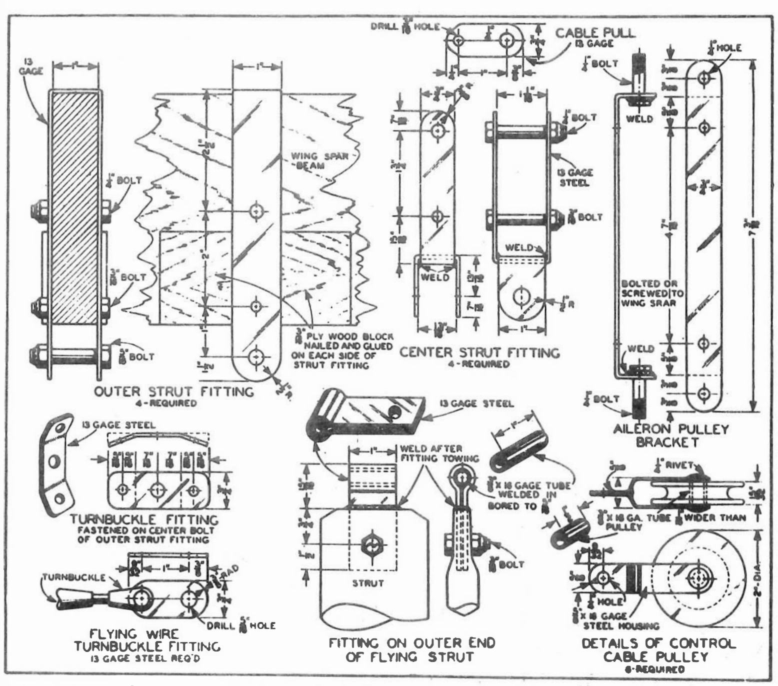
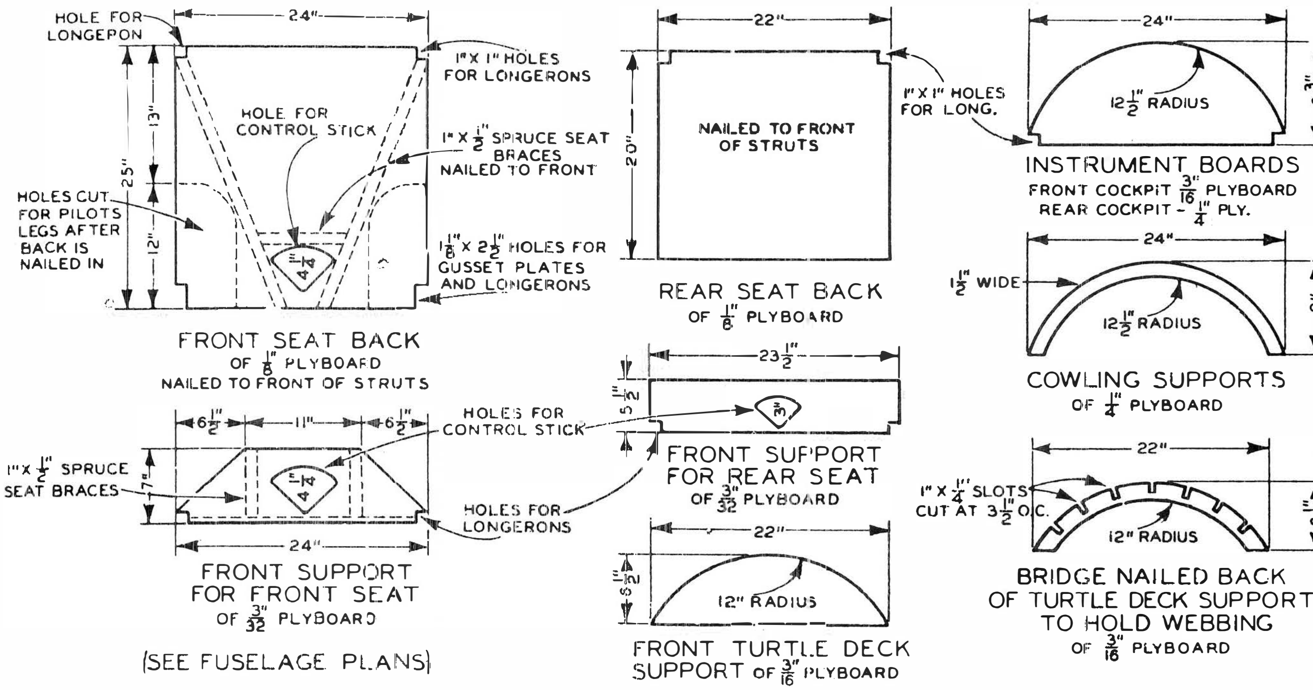


Fig. 3C. The spar fittings for the strut attachments, as well as the pulley, turnbuckle clips, and strut ends, are clearly shown above.



Here are the detailed dimensions for the bulkheads, the seat supports, and the turtleback fairings.

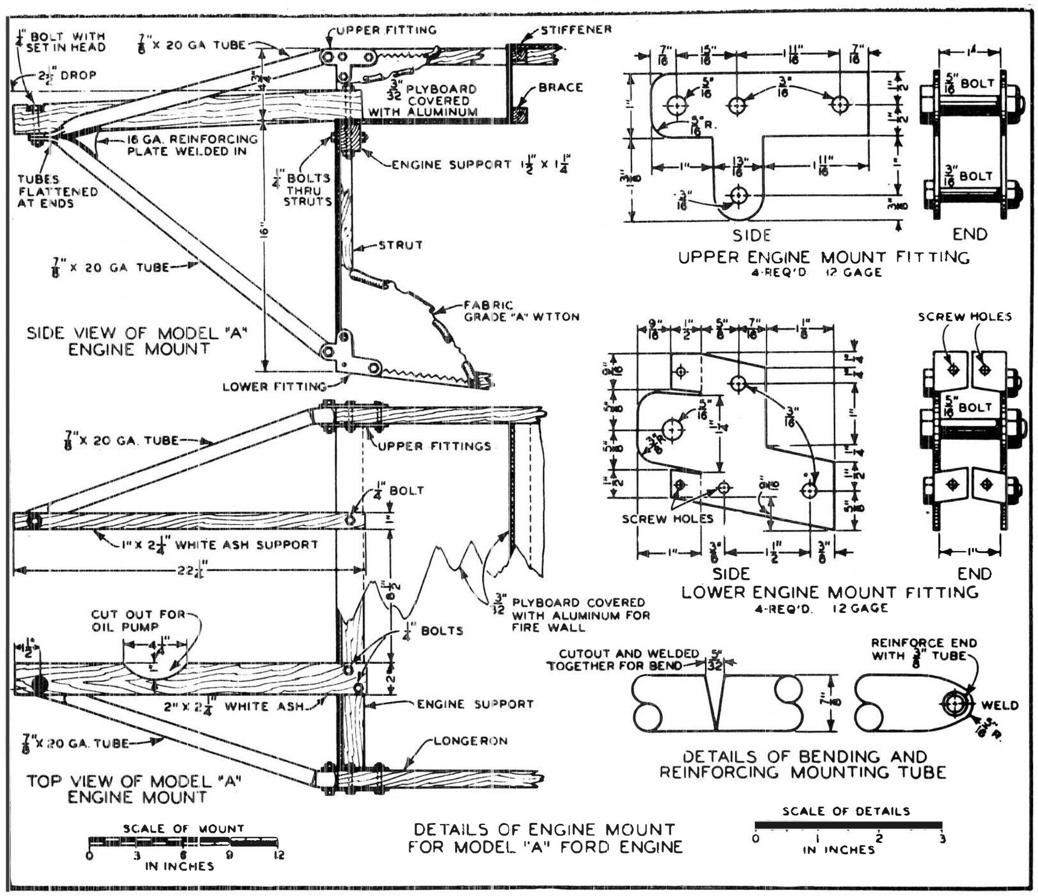


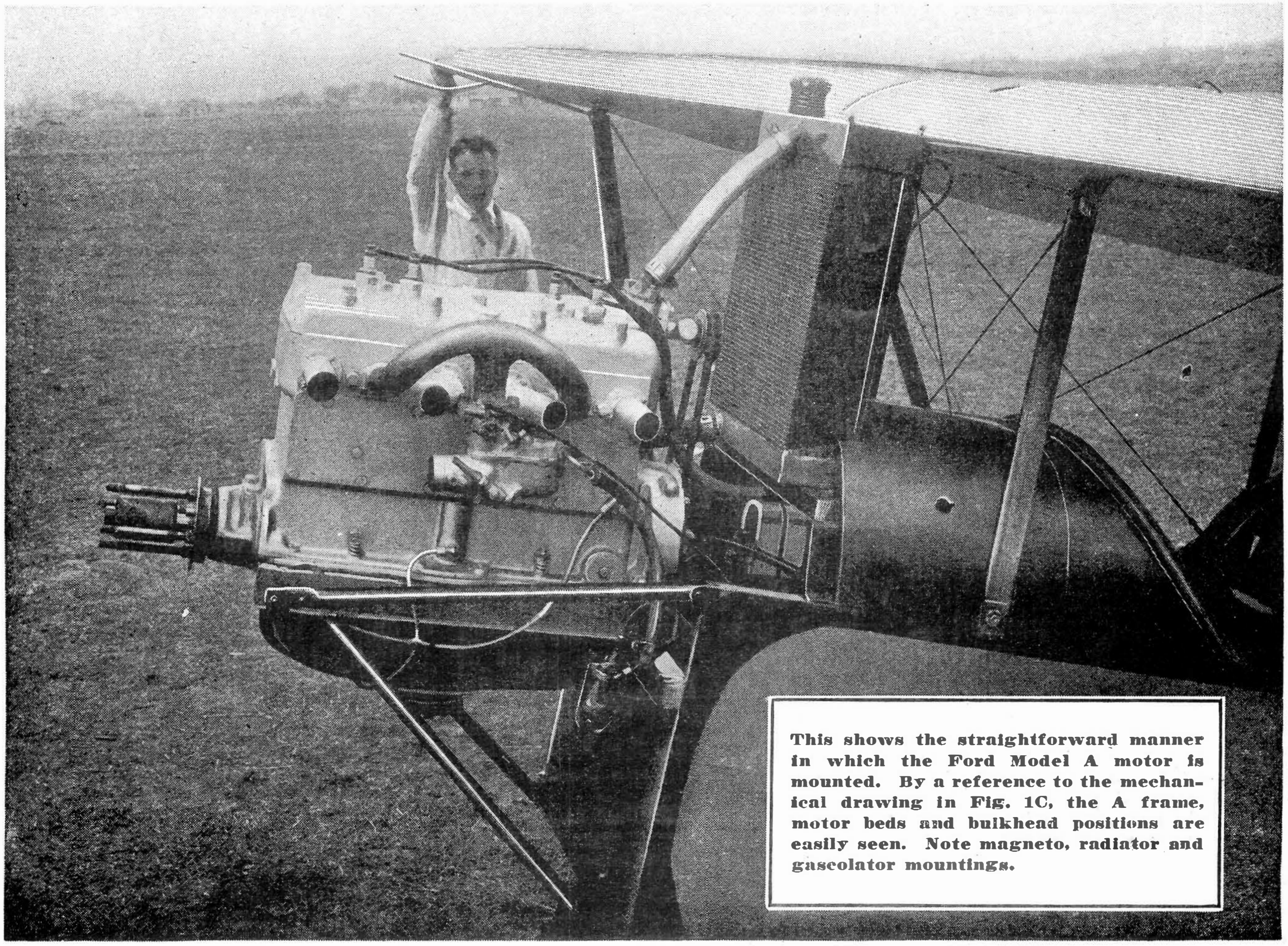
Fig. 1C. This shows details of the motor mount. Bend fittings cold. Never apply heat in bending.

All vital dimensions are on the set of plans. The design is remarkably complete. And we won't monkey with steel-tube undercarriages or other flare-backs. If you want to experiment with her—it's yer own option. I canna prescribe.

Let's look at the motor mount. That is one thing on which I could write volumes. And the mount I have designed after many a flunk in the School of Hard Knocks, is the one shown in the drawings in Fig. 1C.

Simple it is, and ties right in to the nose of the fuselage like mucilage on a piece of blotting paper. The whole mount suggests itself to me as being less an attachment than a part of the ship itself.

Two pieces of white ash, one of them 1 in. by $2\frac{1}{4}$ in. and the



This shows the straightforward manner in which the Ford Model A motor is mounted. By a reference to the mechanical drawing in Fig. 1C, the A frame, motor beds and bulkhead positions are easily seen. Note magneto, radiator and gascolator mountings.

THE WORLD'S STURDIEST MOTOR, FORD MODEL A, MAKES IDEAL AERO ENGINE

You embryo airplane constructors, if you've been following these plans closely, have the "backbone" of your Air Camper — the wing and fuselage — all built, and are ready for the finishing touches which complete the plane.

Now it is time to go ahead with the *"petits details,"* as we used to murmur in France. Things like ailerons, control surfaces and such things really must be used on an airplane if you want to navigate her. That's accepted practice among the best airplane designers.

Let's start off with a flare back on the undercarriage. One or two fellows have asked fcr a word on that made up in steel. The drawings were presented last month, and I thought them so complete as to need no explaining, but it seems that a steel undercarriage — sometimes termed "trucks" by unknowing writers of pulp paper fiction — would be much desired by the all-steel fans.

I say don't go in for the steel-tube landing gear. The plans as shown are for a gear similar to that of the old Jenny. Of course, you could clean it up some, and might possibly gain a few feet per mile bettered performance, but inasmuch as the Jenny gear was the creme de la creme of roughneck airplane b o t t o m s, serving for fifteen years the needs of all crash landings of cub pilots, it has proven itself times beyond count. I didn't want to go into steel-tube for the landing gear after experience had proven the one I designed, and which was shown in the last chapter, was ample, adequate and above all, cheap.

The question of where to draw the line at the exposition of directions for the building of a ship like this is difficult to settle. Some want just a lot of dimensions repeated in the text that are a thousand times more eloquent on the drawings, and some would even have you tell them how to hold the hammer. And there are a few who, after having been told how to hold a hammer in the building of a ship, would ask you how many swipes to clout the nails on the head. So I am adopting the course of telling you the hidden quantities in the design, outlining the major methods of attack in building her, and am not concerning myself with questions like what speed would a Townend ring give her, and couldn't we put a steel undercarriage on her. I say go ahead and build her. The methods will largely furnish themselves according to your knowledge and the equipment you have at hand.

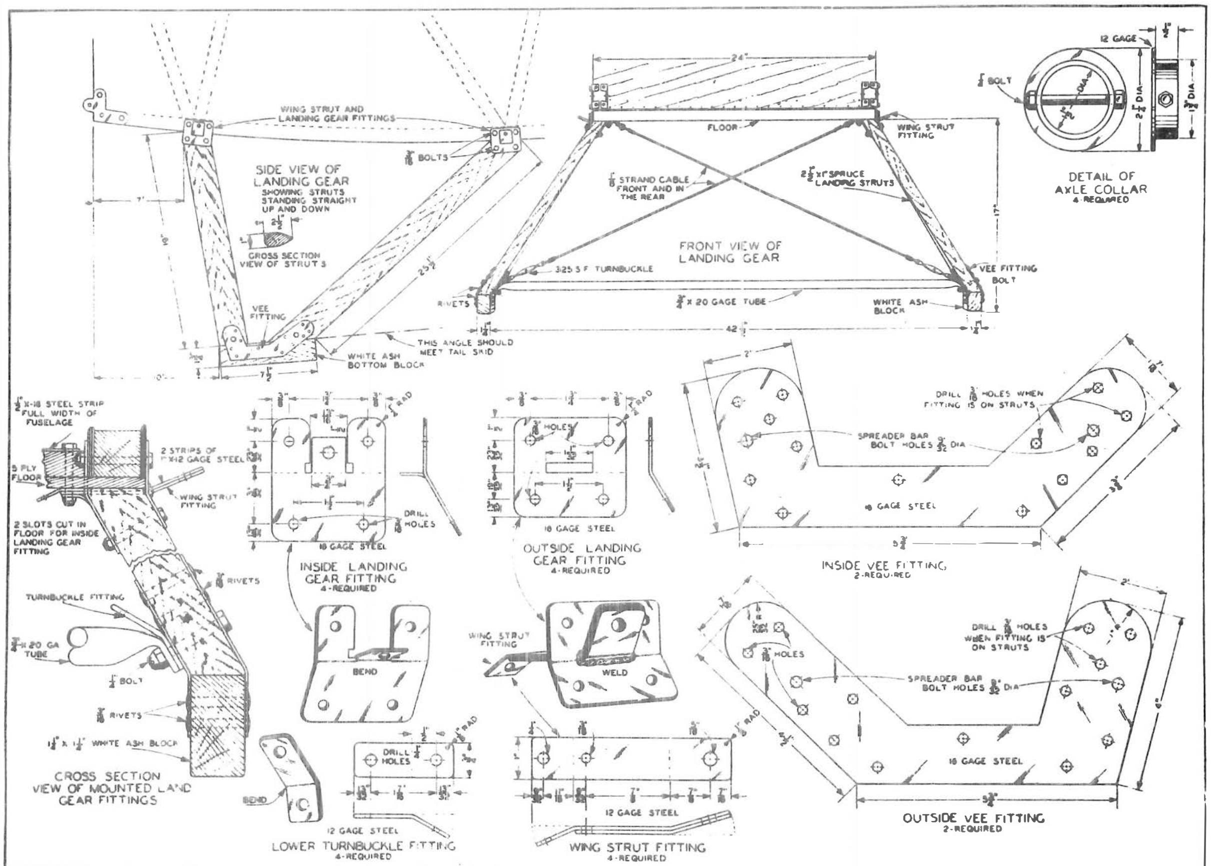


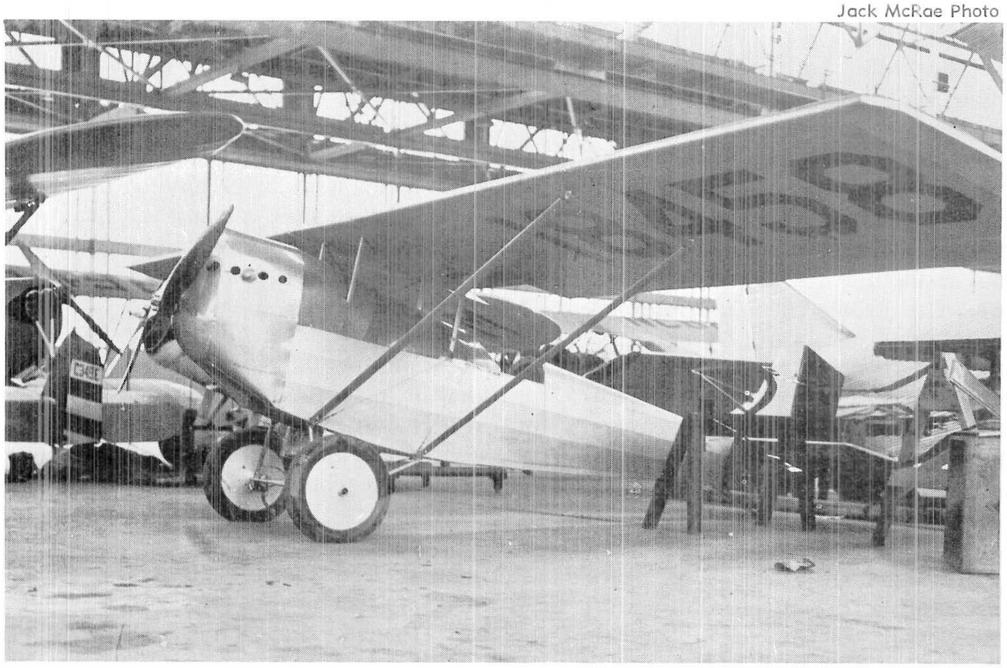
Fig. 6A. Here are all the details of the landing carriage. The fastenings, the fittings and the method of their attachment are all detailed. Fittings are of cold rolled sheet steel, cold worked.

ing and finally the pillowslip covering of Grade A muslin for a cover.

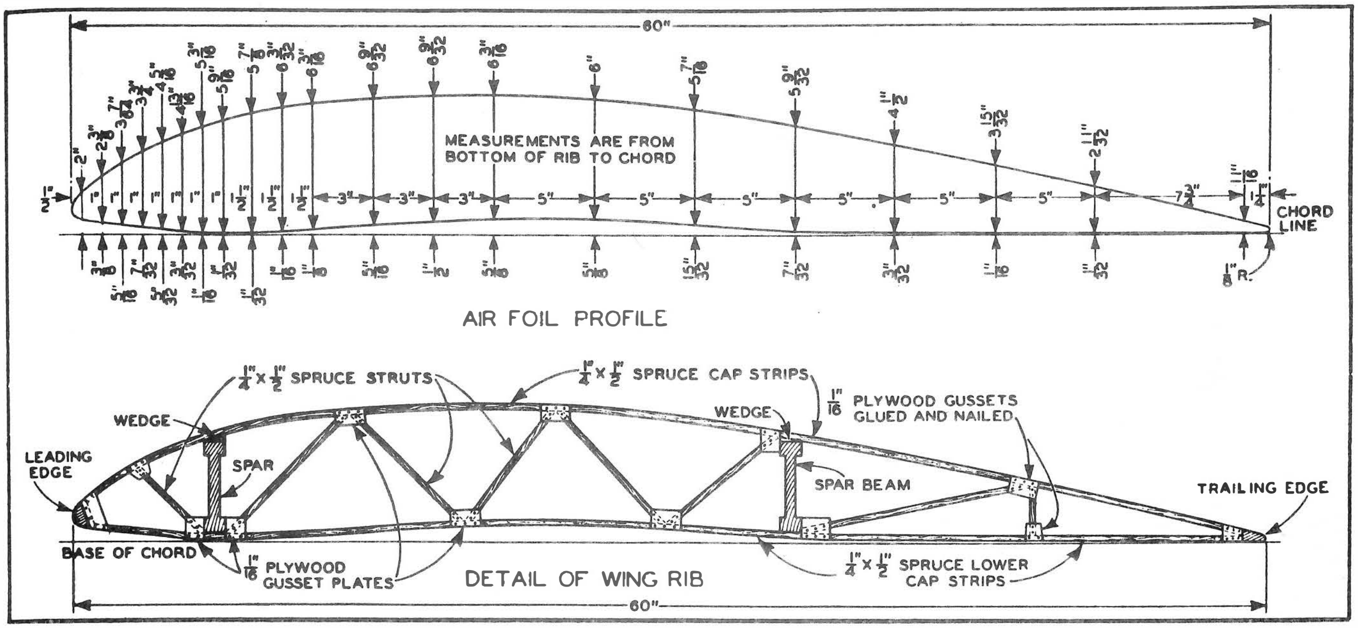
In doping the wing, after the sack has been sewed to fit, and has been sewed to the wing, the edges along the ribs and the leading edge are doped with a good grade of nitrate dope. When this first doping has dried the next may be put on all over the surface of the wing. At the end of the second or third coat of dope the pinked edging is coated on and one or two more coats will finish the job. The first two or three coats of dope will not do much more than barely tighten up the cloth. The first coat will leave the covering smooth, the second will tighten that up somewhat and make it easier to put on the second coat of the stuff, where the third will leave the surface rather drum taut. At least an hour or two on good sunny days, and maybe even a day or two during damp weather should be allowed to slip by as a drying interval.

Now for the coloring of the wings. Some will like to use aluminum or bronze powder sprinkled into the dope on the last two coats. (More than five coats of dope should never be used on a wing as it sets up unusual strain on the surface). Others will want to use paint. I used an orange paint on the ship you see in the photo of the undercarriage, and it worked well when half varnish was added. Just take a glossy paint and add half varnish and a little drier until you have a normally thin mixture, and brush it on. It will need a lot of time for drying though. • • •

Jack McRae Photo



Pietenpol CE-I built in 1938 by Charles E. Truss of Wayne, Mich. Powered with a Ford "A" 50 hp engine.



This is Fig. 5A, and shows the Pietenpol wing curve, which is the result of long experimentation on the part of the builder of the ship. The gusset plates and cap strips are very heavy.

there, that's all I wanted to worry about. *Where* it was and how much didn't bother me. So we built up a bunch of wings, and flew them. The spar depth varied in all of them. I tried Clark Y, and a lot of others, but the section that outshone all the others is the one shown in Fig. 5-A. Don Finke, a neighbor who flies as though he were born in a plane, and myself sketched it out one night out of our heads, and when we tried it we found we had a curve that was about as fast as the best of them, but would lift two people like a balloon, whereas others we had tried wouldn't get two people off without a long run.

I am told by experts that the curve is practically an Eiffel 36, with ordinates increased 25% all along the chord. Westy has all the dope at his fingertips, so he must be right. If so, that may account for the phenomenal performance and stability of this curve. Eiffel was a good engineer too, y'know. The Eiffel 36 was the curve used by the Curtiss Jennies.

The spar in the wing plan we finally used as being best and stoutest is shown in the large drawing of the wing. These spars handle a load directly proportional to the load of a Swallow TP spar. Each is slightly larger than a TP spar. We wanted to have the wing stress analyzed, but when Prof. Wise, who engineered the Mohawk ship analyses, took a look at the wing, he said, "Plenty strong! No need to go through any analysis on that job, unless you want to save weight."

And we didn't want to do that becaus the ship flew like a homesick angel anyway, and for cross-country work — which we have done a lot of — we wanted her husky to the point of ruggedness. That she is as shown.

The spars, dimensioned 4¾ in. by 1 in., are spliced at the middle. The method of making the joint is shown. The fayed surfaces of the spars are carefully matched and the casein cold-water glue stuck on as described last month.

The three bolts of 3/16 in. nickel steel with washers are sunk home through drilled holes. No need to take them up any tighter than to just make them sink the washers home even with the surface of the wood.

The spars, of spruce, of not less than 8 annular rings to the inch, are routed as the drawing shows. This routing is done to save a little weight, and must be done carefully, making sure that the rabbeting plane doesn't chisel in under the grain. The corners should not be as sharp as the section in the drawing shows, either. It would be better to work in a little fillet.

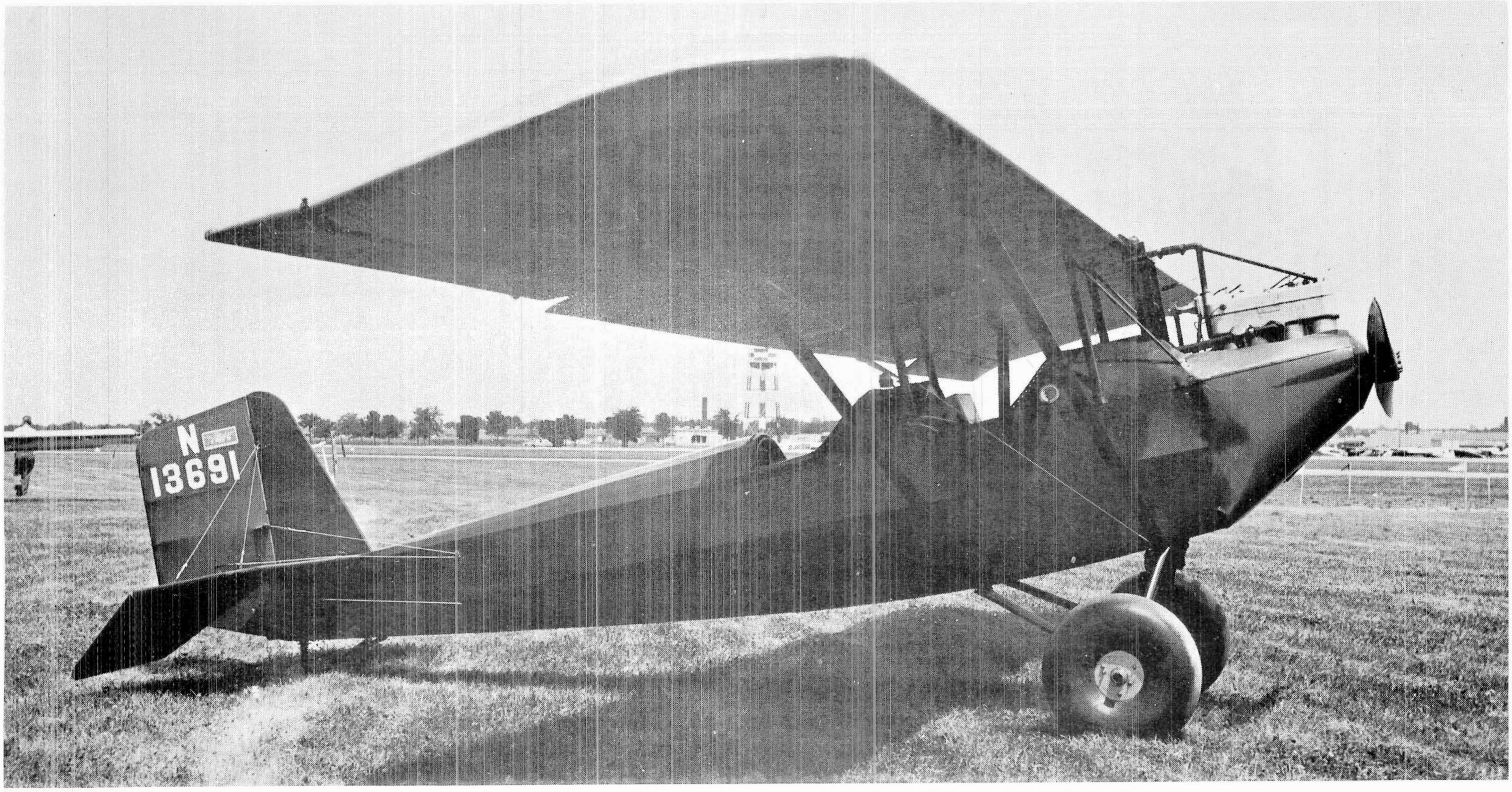
Both front and rear spars are alike.

The slanted openings are filled with cork wedges or spruce wedges where the wing ribs cross the spars. They are fastened in with casein glue. If you use nails to fasten the ribs to the spars, make them light brads and fasten them in near the edge.

The wing ribs themselves are made up in the usual manner with a template or jig. These ribs are exceptionally strong and heavy. The cap strips are of ½ by ½ spruce and the struts are of the same material, the plywood gusset plates of 1/16 in. 3 ply Haskelite or similar plywood. Light nails and casein glue hold them in place. You will need 28 ribs.

Just one little correction while I am at it. The drawing at Figure 5-A shows a dimension of 6 in in the top center of the wing section just a litle below and to the left of the figure 60 in. See it? It's wrong. Should read 6⅛ in. instead.

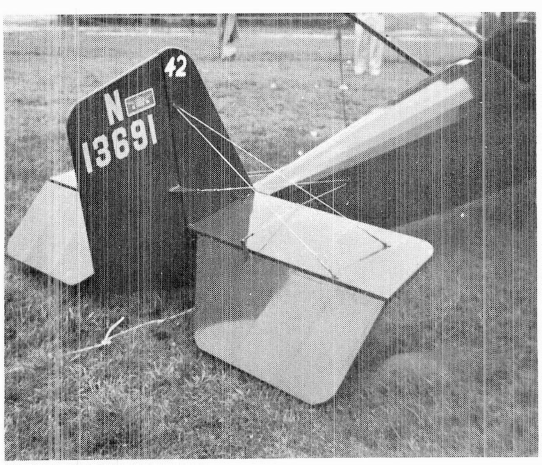
The wings are built up the regular way. Spars built first (no dihedral, Clotilde) and then the fittings fitted, slipped off and the ribs slipped on, then the cap and trailing edges fitted, and then the fittings, the tank, the drag brac-



Allen Rudolph's beautiful Pietenpol Air Camper with a Ford Model A engine.

building aircraft. All of the properties of the metal go up the flue when heat is applied.

The dimensions of the horns are easily seen. The side view in Fig. 3-A is made in duplicate, and enough stock allowed for a gentle bending curve along its fore-edge. It is welded at the rear, and the section at A-A then becomes as shown in the drawing. These horns, two required, should be made accurately when the metal parts for the ship (which are the hardest, and which should be done first if you want to avoid discouragement in building the ship) are done up together.



Ample control surfaces are rugged and simple to build.

A reinforcing strip which adds to the stiffness of the aileron more than anything else, is run from the ½″ spruce aileron spar back to the spruce ¾″ member in the aileron. There it is fastened with bolts as the drawing, Fig. 4-A, shows. In this drawing you will find the methods of attaching the leading and trailing edges of the wings. Good point to remember when building the wings, which step we come to next.

Fig. 5-A shows the wing curve I use. I don't know what to call it. I made it up myself after building a lot of wings. It has proven to be the best curve I can find for the ship. I started out with a Goettingen 387, but I couldn't lift hen feathers with that wing. It was light, and the ship weighed just the same, but it took a long time to get off the ground, and climbed slowly, so I junked it.

Now I'm a practical man. I don't know mathematics much—enough to figure out the major loadings, wing areas, and so on, but as far as saying "hocus pocus" to a Reynolds' number and having a wing coefficient pop out at me, I'll have to excuse myself. What engineering ability I may have is a result of lifelong skill at doing machine work. Westy Farmer tells me the best engineers are the fellows who graduated from the School of Hard Knocks, and I guess he's right. Somehow a fellow gets a sense of proportion about what is strong enough, and what isn't, by merely being around well engineered work all his life. Anyway this wing question didn't worry me any.

I knew that the centers of pressure in a parasol type of plane couldn't shift any more than enough to make the ship slightly nose heavy or slightly tail heavy on trials, and that when I had found out where the centers of lift were I could place them ahead or behind a little at a time until I had a flyin' sweetheart, as Andy says.

So all I worried about was getting a section with a good lift coefficient, and I didn't worry about the bugaboo of that dreadful name, either because I knew when I had hit the section that gave the best all around performance and carried the biggest load, why, the lift coefficient had to be good. As long as it was there and as long as I knew it was

Use the dimensions exactly as shown in the drawing and don't deviate a hair, or the value of the stress analysis will be thrown to the winds.

At the fore ends of the fuselage, and at 2, 3, 13 and 12 there are the fittings for the struts and the motor mount. These will be dwelt upon at a later time. They are simple to make and are welded in place. Fig. 2A shows the method of joining two different sizes of tubes. This is called fish-tailing.

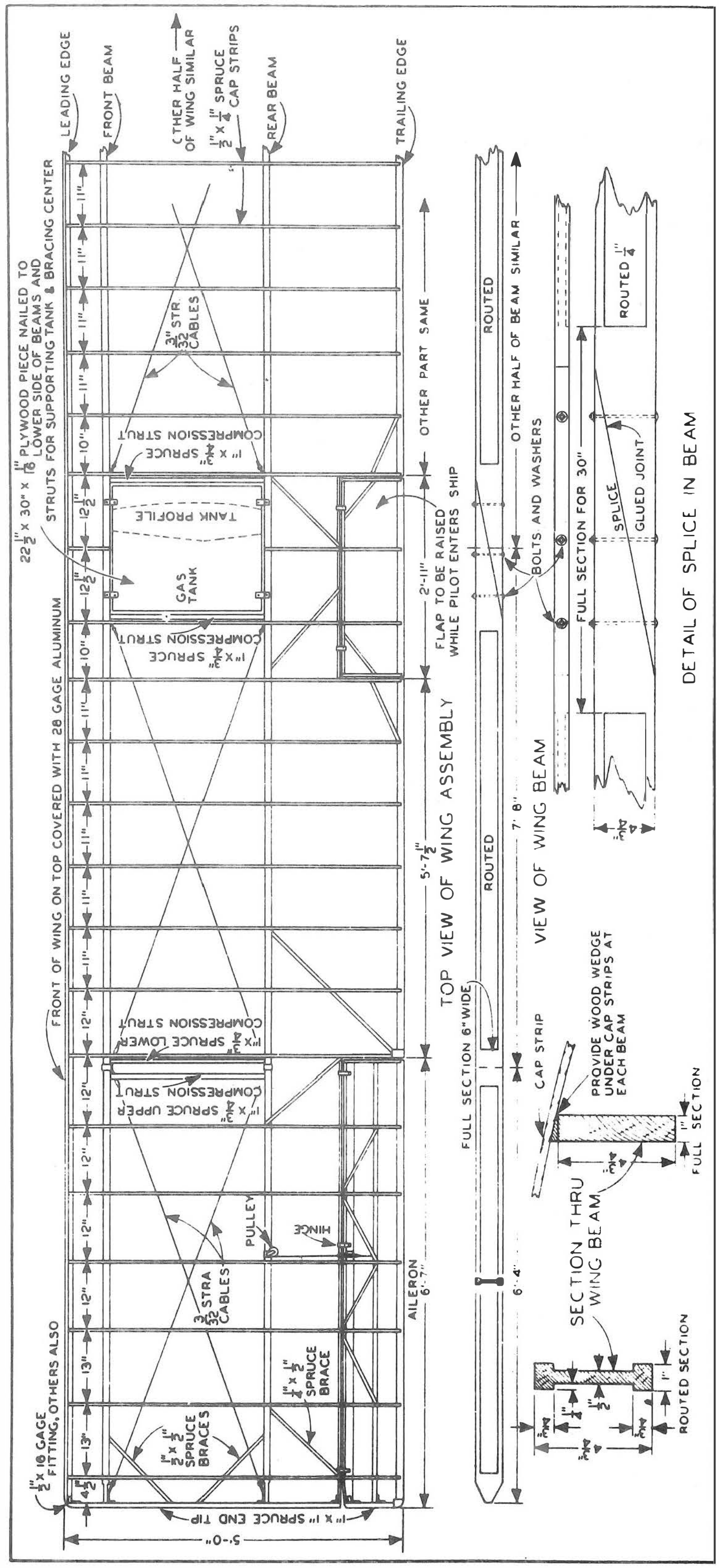
A lot of constructors have different methods of doing up the final finishing of the fuselage. After the welding has been done, leave the oxide on the steel tubes. Don't try to brighten them up with emery cloth as they'll only rust. Some fellows paint their steel stuff gray, others red, others dip it in lionoil. I like that method the best, or if it can't be dipped, as of course cannot be done by amateurs, lionoil can be painted on. It is transparent, more weatherproof than varnish, and one can see flaws as they develop. (Which isn't likely. Rust, weather, and the normal landing shocks encountered in use have little or no effect on a steel-tube fuselage. Routine inspection for failure, if made after unusually hard landings, or at least twice a year, will be ample to ward off any weakness which may develop).

Aileron Fittings

But that is for the steel-tube fuselage — that little talk. There were one or two fittings to be talked about — left over from the last chapter.

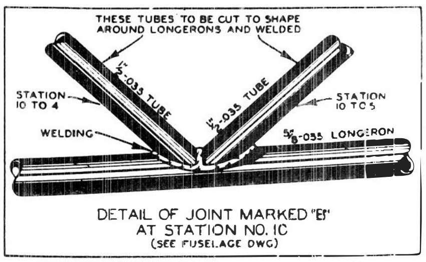
These were the fittings for the ailerons. You remember we were talking about the making of fittings when that last chapter came to a close.

The method of attaching the horns to the aileron spar can be readily seen by reference to Figs. 3A and 4A, when the time comes to put the wing together. Suffice it to say for the present that the horns, one for each aileron, are made of 20 gauge cold-rolled sheet and are made with all bends cold. Never heat rolled steel in



the plans are shown in this installment. The tubing specified is of the standard variety, obtainable from any aeronautical supply house such as the Heath Airplane Co., 1727 Sedgwick St., Chicago, Ill., or the Church Airplane Co., 4844 Nevada St., Chicago, Ill. The size of the tubing is shown by the letters alongside the different members in the drawings. For instance, ½ in.-.035 means half-inch diameter tubing of .035 gauge.

In building the steel fuselage, several precautions are necessary. First, you must have the right tubing in the right place. Second, the welding must be done by a man who knows how to weld. If you don't know how yourself, you can hire a welder to come to your shop. In a day



This drawing shows the way the strut tubes "land" on the longerons. Use care in welding.

or a day and a half he should be able to completely weld the fuselage together. Third, the material must be all cut to fit right to the dot and brightened up at the weld so you get a clean fit and one in which the weld is from tubing to tubing rather than filled in with welding rod too much. Given these conditions, the complete fuselage will in every way be equal to a factory job.

I will weld up these fuselages myself for anybody who wants them. I can give you a reasonable price, too. Or if I'm too busy to do it myself, I'll have a fellow weld it who knows his groceries.

The first thing to do is to lay out the sides and the top and bottom plans of the fuselage full size on a floor. Then the tubes are cut with a hack saw so that all the longerons are in place, and so that all the struts in the bays, of the right sized tubing, are in place right to the dot. Lay out the center lines and then

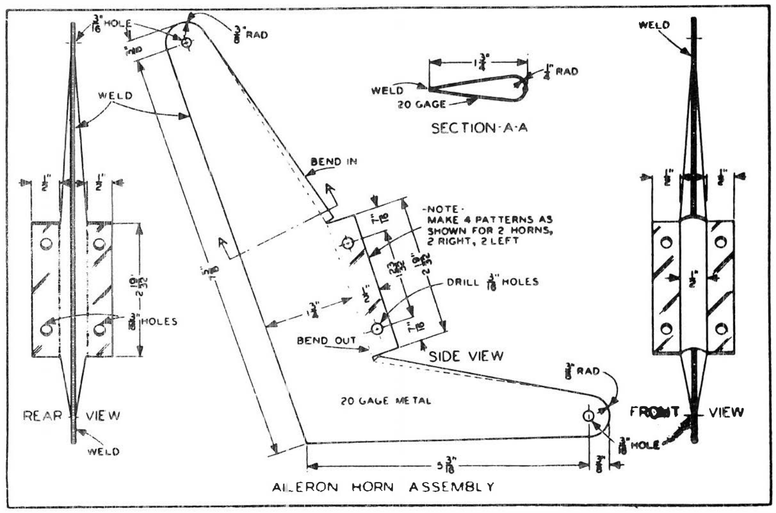


Fig. 3A. The aileron horns, two required, are laid out as above drawing shows. Allow for the bend at the head face of the cross section A-A.

make the center lines of the tubes coincide with the center lines of the fuselage as laid out. This assures that all the joints will hit at critical load points and that there will be no eccentric loadings on any of the tubes.

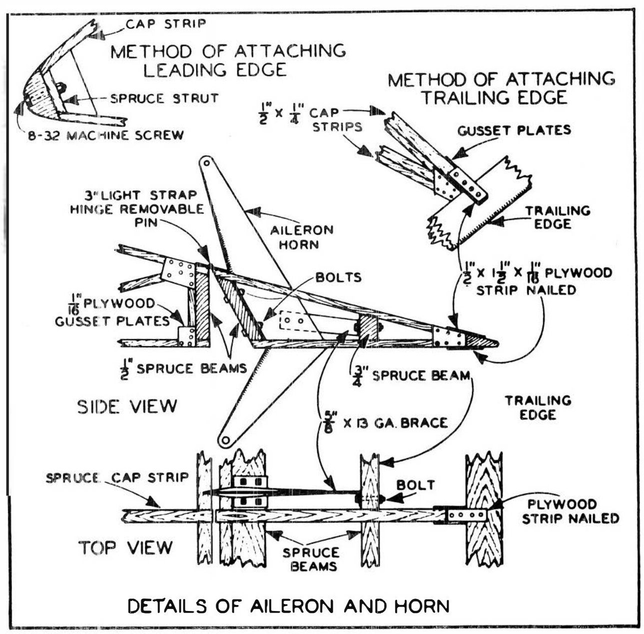
Then tack-weld each of the sides together. Then turn them bottom side up, and with the top longerons on the floor over the top view, tack in the cross members for the top. Jigs will have to be made to hold the work while you are welding it. These can be made from wood as well as not. By referring to the blueprint you can see that the cross frames run from 4 left to 11 right, and 3 left to point 12 right, and 1 left to point 14 right. All these tubes are ½ in.-.035 S.A.E. 1025 tubing. Figure 1A shows how the fuselage, after being tacked, is put on a horse and welded up completely. The torch is applied joint by joint, going in a clockwise and rearwards direction.

This is done to avoid twisting. The alternate expansion and contraction of the metal would give you a badly warped fuselage if you jumped about hit and miss in your welding.

The detail of the joint at point 10 on the fuselage is shown to enable you to visualize how the weld should look.

All the dimensions are shown. It is not necessary to scale the drawing, although a scale is shown. This is more for handy reference than for anything else.

Fig. 4A. This shows the wing horn anchorages and the wing construction. Note hinged flap at rear of wing (shown following page) to admit pilot.



Steel-Tube Fuselage Has Been Stress Analyzed and Found Amply Strong

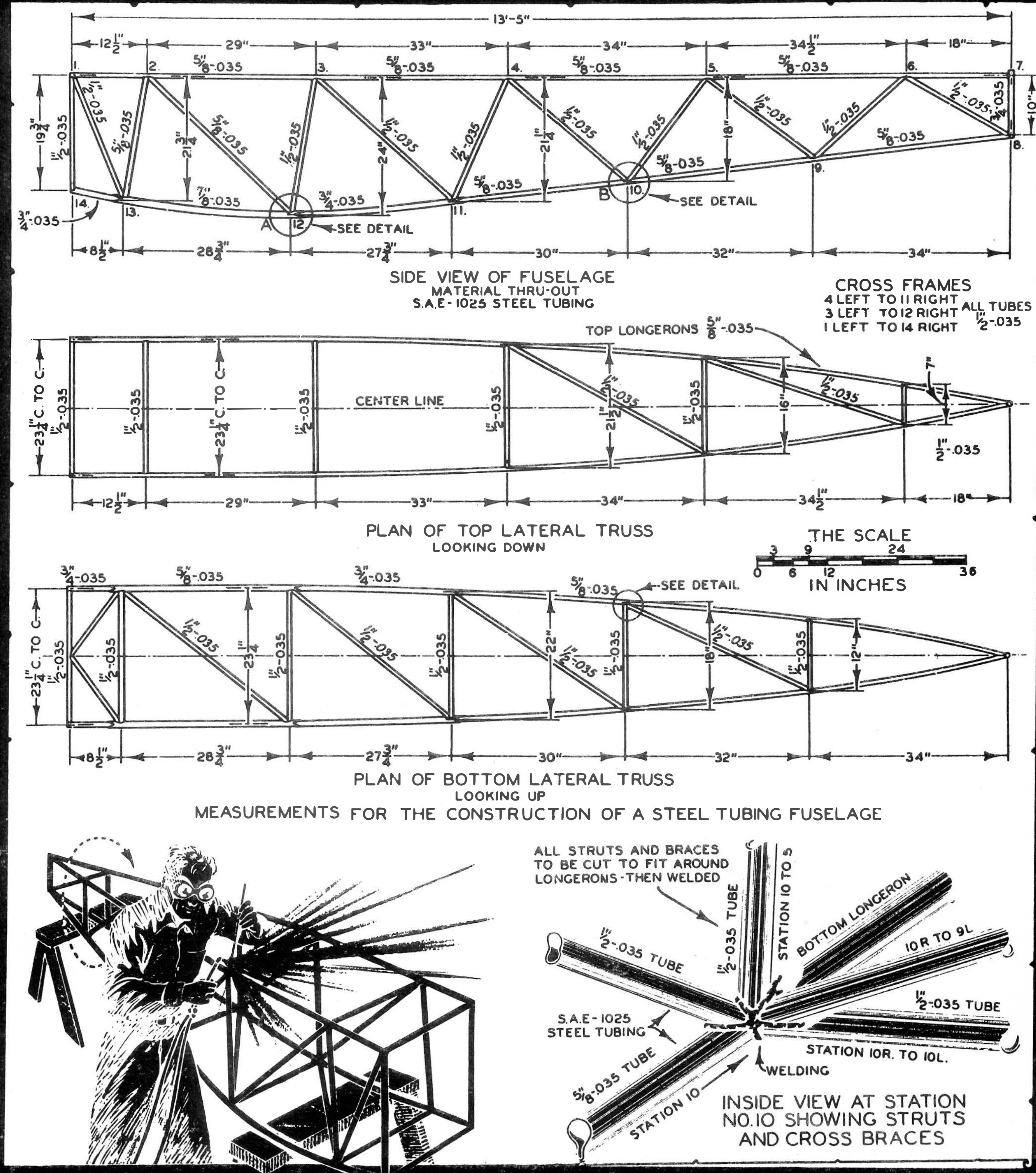
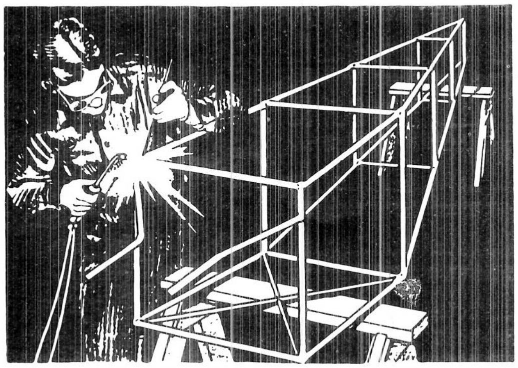


Fig. 1A. When laying out the sides and the top and bottom panels, use the center lines as absolute guides. Note manner in which the cross frames run. Fuselage has been stress analyzed.



If you prefer a steel-tube fuselage for your Air Camper rather than the wooden job described in Part I, you'll find the plans for it below. Aileron fittings, construction of the wing using the special air-foil developed for his plane by Mr. Pietenpol, landing gear construction and other details are presented in this installment. The Pietenpol air-foil is designed to aid the Ford motor to lift his loaded two-place plane off the ground in a hurry.

You have just finished reading about the construction of the wooden fuselage for the Pietenpol Air Camper — now I'll go on and present the details of the steel-tube fuselage which many of you plane builders may prefer to the wooden type. The Air Campers which I have built for myself have all been fitted out with the wooden fuselage, which I have found to be entirely satisfactory, and easier for the average amateur to construct. Many of you boys, however, will prefer a steel-tube job.

Now this fuselage is unique in many ways. It is designed to meet all of the requirements of the Department of Commerce. All the load factors have been diligently worked out by one of the most skilled airplane engineers in the country. His name is Joseph Wise, of the engineering faculty of the University of Minnesota.

When I was talking about the publishing of the Air Camper plans with Weston Farmer, he suggested that we get a steel-tube fuselage designed which would satisfy all of the boys who wanted steel-tube jobs. The conversation we had ran something like this:

"I'm working up a steel-tube fuselage, too. We could run that," says myself.

"Good idea," answered Farmer. "But let's get one from Wise. He'll give us a detailed stress analysis, and while the job will not be any better than your time-tried wooden fuselage from the standpoint of usability or practicability, still it will have an added value to the fellows who would like to build either way or who would like to compare the two methods of going at the thing."

So Prof. Wise did the job, and

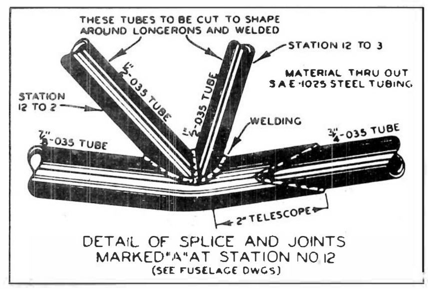
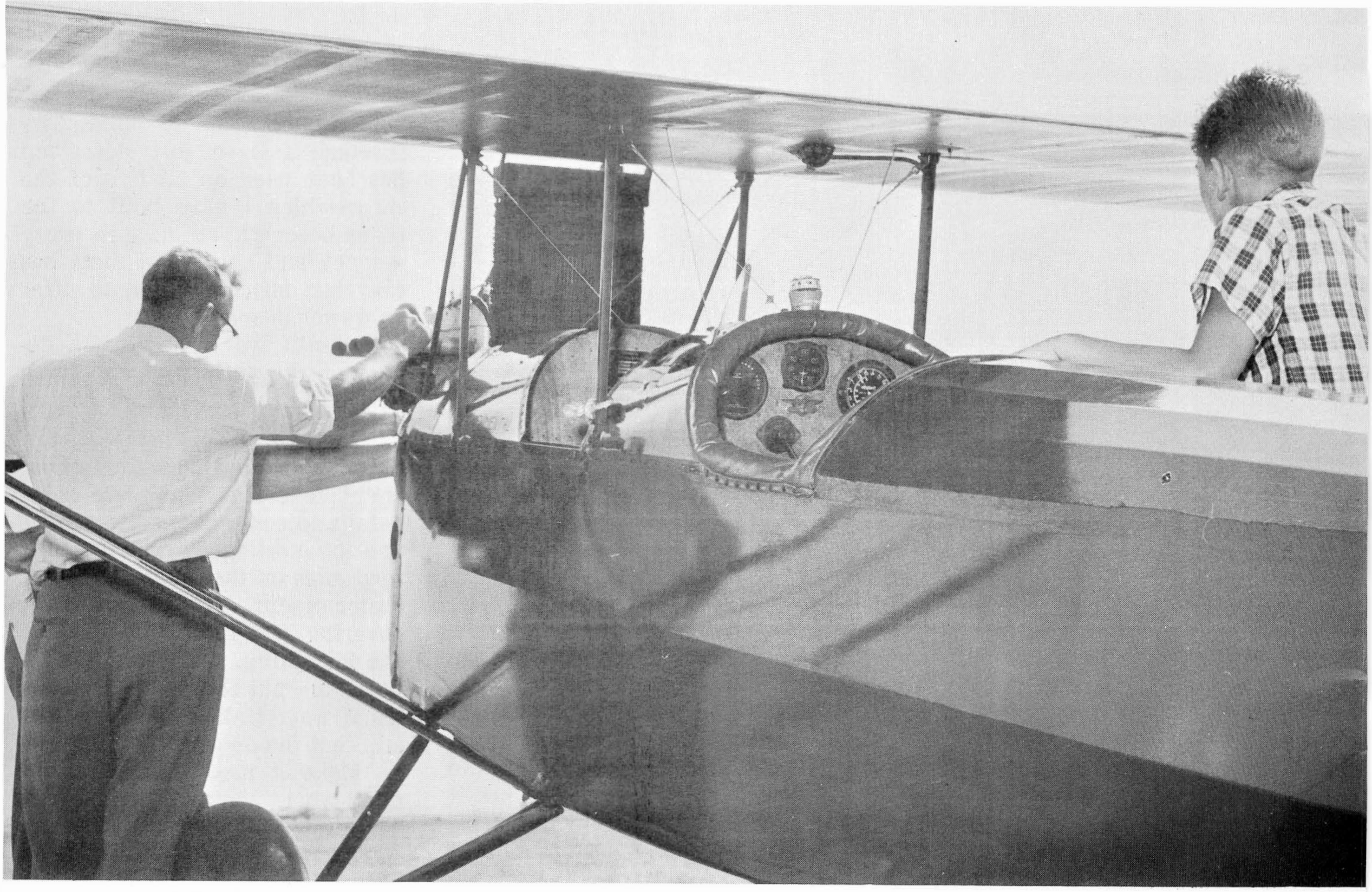


Fig. 2A. This shows method of fish-tailing longerons together. Note manner in which struts "land."
The welder should work around the fuselage in a clockwise direction, starting at the fore end. This method eliminates possibility of warping.

A Canadian built Pietenpol, CF-RAZ, that was built in 1934.



Plenty of fresh air flying with this beautiful Pietenpol Air Camper owned by Allen Rudolph Dick Stouffer Photo

After an hour or two it will begin to get thoroughly dried out and to harden the cloth just a little bit, but it will be far from stiff and taut. The second coat will go a long way toward making the fabric this way, and here I would allow the stuff a full day's time before applying the third coat. Then the third and fourth coats could go on the next day. I don't think a pyroxylin finish should be applied. I have found that the solvents used in paints like that soften up the dope and make the whole covering job sag like a sow's ear.

The little job shown in the photograph is painted with an orange made from a standard grade of enamel thinned with varnish. It looks very well and has stood up nicely. I am referring to 77W. Ship No. 899H is covered with aluminum powder in the dope. This stood up very well. In case your curiosity gets the better of you, let me say that the numbers on the planes are merely file designations and the W or H have nothing to do with anything but the system of filing the numbers at Washington. In this connection, it is possible to get an experimental license on this ship as we have done. It cannot be licensed because, in common with all other lightplanes, it hasn't got the expensive theoretical engineering required by the Department of Commerce before they will license the ship for commercial flying for pay. I have always maintained though that use was a better criterion than theory. The old *Jenny* couldn't pass the requirements of today!

Now about the control system. This is something of my own invention that I am very proud of. By a glance at the last blueprint in this article you will be able to see just how the thing is hooked up. The rudder is controlled by simple U-foot pedals attached to the cross members. The control cables are fastened to the stick at a height I have found by lengthy experiment to give the same aileron and flipper feel that the Waco has. Under the front seat there is the rudder bar, which has to be used because there is not room for pedals. One long torque tube handles both the sticks, and the torque tube handles all aileron action. The wires run only to the rear stick. The blueprint gives complete details, and anything I might say here would be repetition. The boring and drilling and brazing of the collars is so simple as to need no explanation.

This first part, being in the nature of a get-acquainted chapter, is meant to give you a good idea of the ship and something of what is to come. And having told you about the building of the fuselage in wood, and having shown the plans for the control stick, I am going to close these constructional details and swing back into a recital of the capabilities of this little airplane, sort of giving you a look-see at her characteristics.

All who have flown the job say that she flies about like a *Swallow T-P* except that she is faster in the air. She takes off about like a *Jenny,* climbs about like a *Waco,* and has no trouble at all in handling two passengers. I have used my ship on cross-country work for a long time, and find the motor good for about 200 hrs. with only top overhaul. • • •

Jack McRae Photo

Pietenpol "A" built in 1935 by William C. Harlin, Ferndale, Mich.

with heavy longerons and heavy bay struts. Don't, for goodness sake, build these any heavier than specified, for the ship as it stands leans very much to the heavy, rugged type, and would fly better, though not be so good for cross-country, if it were lighter all through. I thought it better to err on the side of ruggedness.

Covering this side baying are the long sheets of 3/32 in. plywood, or plyboard, as I like to call it. This is laid in cold glue, or casein glue, which you can get in your local hardware store. It is a powdered glue made from distilled milk, or casein, and is mixed in chemically definite proportions with cold water, after which it must be used fresh.

There are gusset plates of the same material on both sides of the fuselage struts and longerons at the points where they join.

The proper method of building up one of these fuselages is to lay the whole side out on the floor, full size, and since it must be a wooden floor to take the nails outlining the bends of the longerons, a jig is made up right on the floor and the longerons bent in around the nails. The bay struts are carefully mitered in, in their respective positions, and the gusset plates put on.

There is no need to use pressure in using cold water glue. All that is necessary is to see that the surfaces are liberally coated with the stuff, and that enough small brads of about ⅝ in. length are used to hold the gusset while the stuff is drying, which should be from one to two days. It will set in an hour, and undergo the union with the fiber of the wood and the chemical change which makes it so unusually strong in not more than two hours, but no motion or strain should be put upon it in airplane work for the length of time I have specified. There is no point in using a lot of nailing. The strength lies in the gusset plate and gluing. After the inside gusset plates are on, the whole side is flipped and the 3/32 in. sheet back to the rear of the cockpit, and the outside gusset plates, are put on.

Then, when both sides have been done, the two sides are lined up and the top and bottom bays are put in. You will note that there is a ¼ in. floor of plyboard set in *under* the longerons and cross bays of the fore end of the cockpit. The stern plates and the stiffeners are put in, and the whole thing varnished to protect it from moisture. When putting on the plyboard it is wise to paint the edges of the grain with paint. Then there will be no trouble with peeling.

The fittings for the motor mounts and the landing gear will be shown in a future installment.

There is a steel fuselage to be shown later, too. All engineered out to Department of Commerce requirements by Prof. Wise, of the Mohawk Airplane Co., and while it is a nice job, it will not be easy for some to build. The fuselage I have just described has been used on all five of the ships which I have built to the plans herewith, all alike in every respect, and not one of them has ever had any complaint to offer an owner in service.

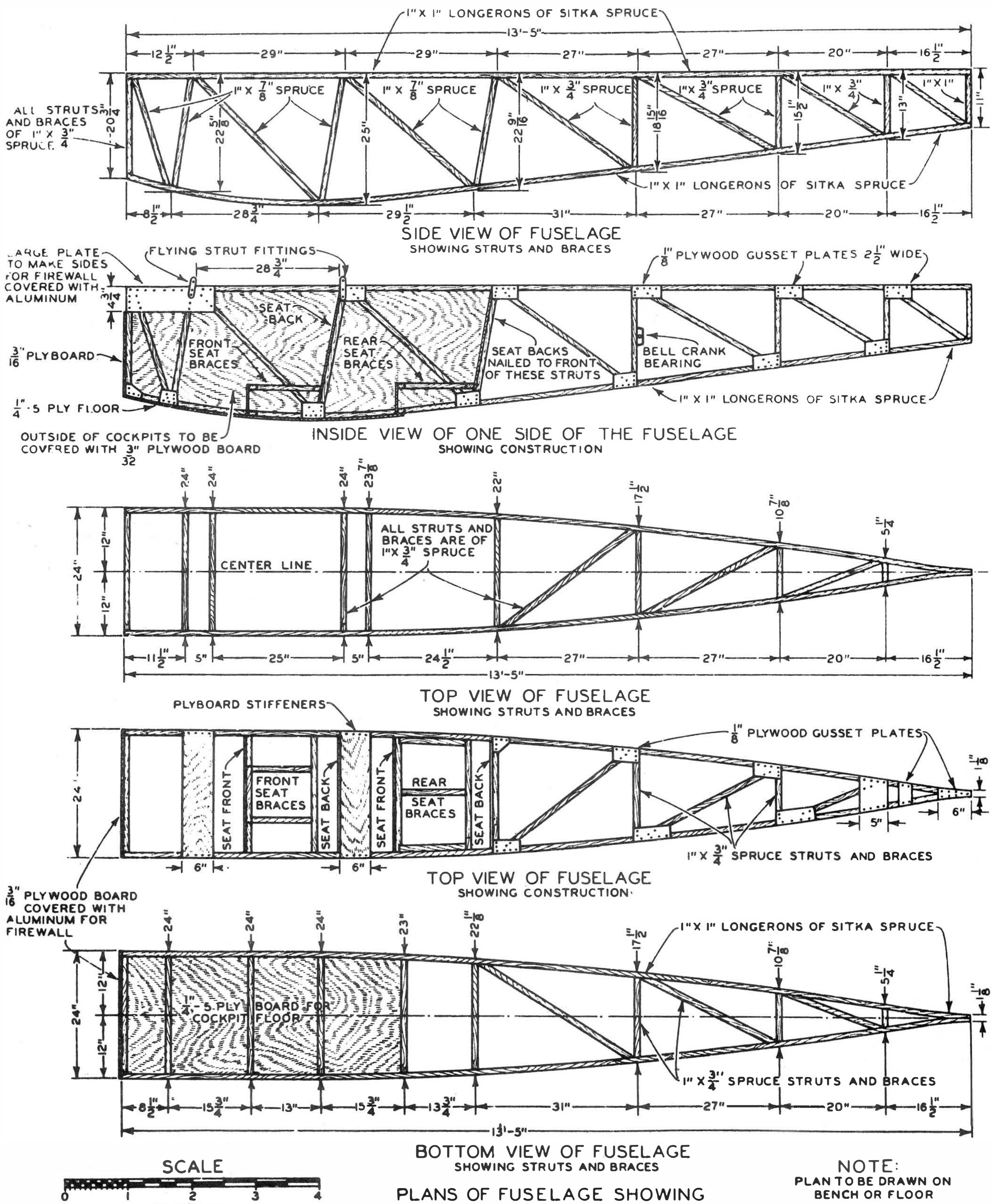
So until we come to the details of the fittings, I am going to dismiss the fuselage as having been completed.

But I should say something about covering. There are some details to come about the fairing and the cowling. There are also a few notes on the fastening of the motor mount. All these affect the covering, and it should be left to the last thing. But when you do put it on, put the cover on in the usual way: Make it like a pillow slip that fits on over the job tightly. Make it just a snug fit, and don't worry about a few wrinkles. The dope will take them out.

You will note as you study the plans that there is a fairing on the side of the fuselage. This is to give something of a streamline effect, and it can plainly be seen in the big full page photograph on page 10. Which statement calls to mind one thing that Andy will thank me for: Study the plans before you decide they are not clear. They have been checked by experts and pronounced complete. Of course, the full size blueprints done in the scale from which these drawings are reduced are a bit clearer, and I will furnish any of you sets for seven and a half bucks, care of Andy, but those given here are complete and should be studied to enable you to get the whole ship clear in your mind, piece by piece.

I would give not more than four coats of dope to the fuselage, and this should be of the nitrate kind, obtainable from any airplane supply house. More than that number of coats won't do any good, and you ought to give it that many to get it drum tight. It won't begin to be tight, either, until it has had that many coats. The first coat will go on and leave the fabric, which is grade A muslin, looking like a wet rag.

SIMPLE, EASY TO BUILD WOODEN FUSELAGE FOLLOWS TIME TRIED PRINCIPLES



PLANS OF FUSELAGE SHOWING MEASUREMENTS AND CONSTRUCTION

Here are the dimensioned detail drawings of the Pietenpol wooden fuselage as used on all ships built by him to date. It is a marvel of strength and has withstood unusually rough handling.

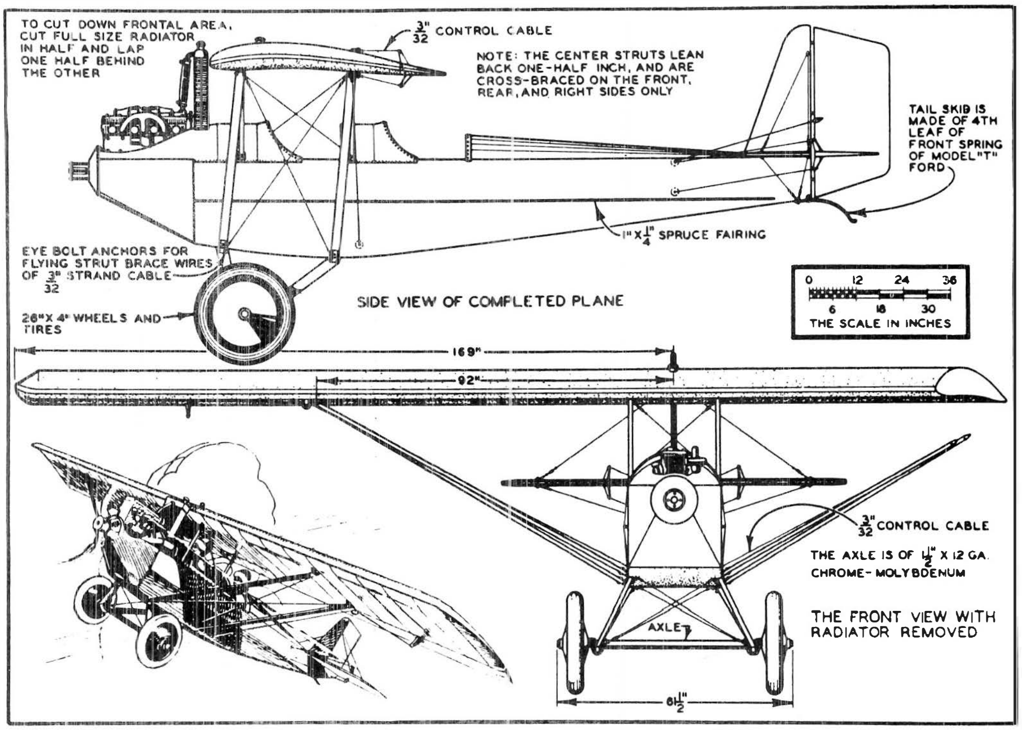


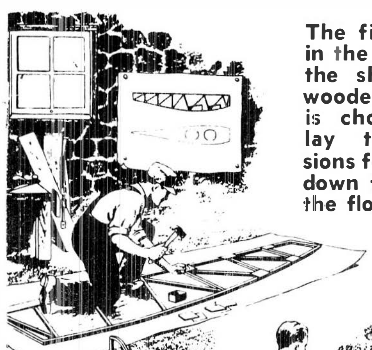
Fig. 1. Here are the outboard elevations and nose elevations of the Pietenpol Air Camper. The two-passenger ship is a fifth larger than the Heath Parasol, so familiar to Flying Manual readers.

er plant known, and (3) that the DeHavilland type of wooden fuselage construction was the lightest and stoutest that could be had at a price within the reach of the average experimenter's purse.

So the design here is the result of a lot of flying, a lot of experimenting, and is as near fool-proof as a low-powered airplane can be.

To take up the features of construction in order of their building procedure, let us start with the fuselage, take it apart as a design, and show how to build it. I chose this for the reasons previously stated, and because I had built enough of them to know what they were like. In an early ship, substantially the same size as the one shown here, and which was powered with an Ace 40 hp four-in-line motor, the fuselage came through a crackup without splintering one iota. It was a pleasant surprise to me to be brought to the realization that the plywood would allow the longerons to bust into a hundred pieces without splintering. They broke up like a bunch of dead rubber, or artgum, and were badly bent from a pancake landing made 20 ft. too high, but there was none of the old toad-stabbing so common with the stick and wire type of fuselage. So I went ahead building them stronger, heavier, and perfectly trussed until I got the result that I have here, and which I am showing in the plans accompanying.

If you will take a look at the blueprint on page 8, you will see the chief features of the design are a well balanced profile



The first process in the building of the ship, if the wooden fuselage is chosen, is to lay the dimensions for the sides down full size on the floor.

When the sides have been assembled and glued with gussets, they are set up on a horse and joined by the top bays.

Then the fuselage is covered and doped in the usual manner.

SPECIFICATIONS OF THE PIETENPOL AIR CAMPER

Weight of Wing, Complete	**95 lbs.**
Weight of Motor with Magneto	**244 lbs., complete**
Weight of Radiator	**21 lbs.**
Weight of Propeller	**15 lbs.**
Total Weight of Ship Without Load	**625 lbs. with water**
Total Useful Load with which it can fly	**385 lbs.**
Square Feet of Wing Surface	**140**
Load per Square Foot	**1,080 max. load lifted**
Span	**28 ft., 2 in.**
Chord	**5 ft.**
Take-Off Speed	**40 miles, approx.**
Landing Speed	**35 miles, approx.**
Flying Speed	**60-75 miles**
Weight of Body, Complete	**130 lbs.**

Pietenpol "Air Camper", N-4968E, owned by Hanson F. Lovely

PART 1

THE PIETENPOL "AIR-CAMPER"

...a Ford Powered 2-Seater Monoplane

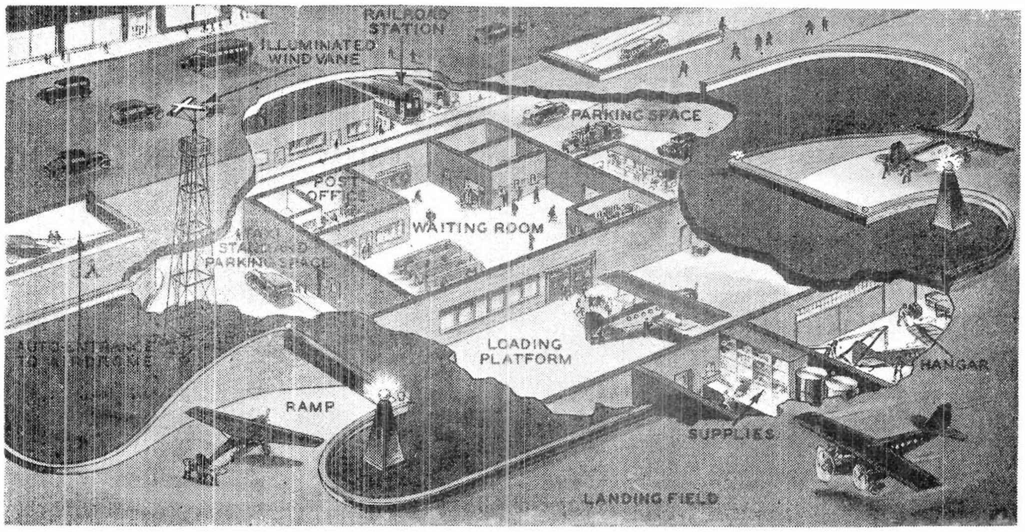
By B. H. Pietenpol
Designer of the Pietenpol
Air Camper

Well, Gang, here we are after a long wait, and let me tell you I think the waiting will be worth while if what the editors have told me is true. They say they have been so swamped with mail and inquiries regarding this job of mine, over which I have so carefully labored, that something had to be done. You probably remember that this little cross-country ship of mine was first announced in Andy's Shop Mail Box in *Modern Mechanics* last spring.

They couldn't wait any longer. They said, "Never mind the fussing and pottering. Get yourself satisfied that the ship is okey, and we'll run it in an early issue. You are too conscientious. Experts agree that the job is finished and a humdinger. Let's get it into type and do the job up brown there, too." So we flew up from our home town to *Modern Mechanics'* own flying field, and got "our pictures took."

Gene Shank, Westy Farmer, Harry Holcomb, and others hopped the little sky busters and said they were pretty hotsy totsy. You've been told all this in the Shop Mail Box. And now that I've seen the pictures, I'm willing to agree that the editors can make this the best airplane how-to-build that was ever published if I just do the necessary writing. So here goes:

After many experiments with building and designing light airplanes, after I had first successfully soloed in a *Jenny* at the end of four hours' instruction, after using the biplane and parasol type of construction, and after using everything from an old Gnome "growler" to an Ace Four and a Model T Ford engine, I came to the conclusion that, (1) the parasol or high-wing type was the simplest type of ship to construct — two spars, no center section and just one wing curve jig needed; (2) two people could be flown with the Model A engine, which offered the most desirable features with the exception of its weight, of any pow-



This cutaway drawing shows an ideal landing field, in which a perfectly level surface is offered for planes to land on. They then can taxi down a ramp, discharge their passengers into the below-surface station, and taxi out again when ready to take off.

require licenses for aircraft only when they are to be used in interstate or foreign commerce. Interstate operation of unlicensed planes is not prohibited by Federal regulations. However, some 20 states have enacted legislation requiring aircraft within their boundaries to be licensed. You can find out if your own state is among this number by writing your local Secretary of State. The Department of Commerce at Washington will issue an identification number for your plane on request.

Your flying experience will soon give you a practical working knowledge of airports, meteorology, and mechanics. Some day you will probably want to apply for a limited commercial or transport pilot's license, and your sportplane experience will stand you in good stead when the time comes for examination. To get a commercial license you have to demonstrate your ability to take a plane out of a spin and do other maneuvers — but *don't try stunts* with your homebuilt plane. Not that it isn't sturdy enough — Air Campers and similar planes built from *Flying Manual* plans have been put through all sorts of fuselage-wracking maneuvers — but ordinary good judgment demands that you confine your early flying activities to straight-away work. One great danger that besets young pilots is overconfidence. After they have been soloing for a dozen hours or so, they feel a yen for doing tricks. Postpone your stunting until your flying hours are counted in three figures.

You'll find it profitable to put in a little time studying winds and clouds. You ought to be able to judge wind velocities and directions to a nicety. No other one weather factor is likely to cause as much grief as winds — most of it needless grief, be it added. For the pilot who knows his ship, and who watches wind directions when landing and taking off, and who knows what's likely to be brewing from the appearance of the clouds, is rarely caught in thunder heads or violent gales. Don't try to fly in windy weather. Your plane is probably sturdily enough built to withstand a gale, but there's no fun proving it.

Learn a little bit about airports, too. There's not much to it; their markings are uniformly simple and easy to interpret. Learn to look for the wind sock or direction indicator; learn to be on the lookout for air traffic when landing or taking off — the air is getting as crowded as city streets in the vicinity of airports. Larger airports have starters who signal planes when they can take off —smaller ports rely on simple "right of way" rules which every pilot learns.

Airports are developing rapidly to keep pace with increased demands on their facilities.

The art of cross-country flying is not so simple as it seems. You have to learn how to read a map in the air, and how to interpret its information. You have to learn how to pick out rivers, railway lines, and other landmarks, and follow them to your destination. If you can afford it, equip your plane with a compass, drift indicator, and other instruments which help the blind flyer — and learn to depend on these instruments, rather than your own impression of circumstances. It's absurdly easy for a young pilot, and even an old hand in the game, to get entirely twisted about in his sense of direction. You can fly directly south, and be willing to bet every cent you own that you're heading north!

All of these nuggets of information, however, come to you gradually. Soon flying is second nature to you — that's why each hour of flying time you build up on your homebuilt plane is priceless. Expense of running your plane will vary somewhat according to your motor and general design, but as a rule your flying hours cost you much less than 5 cents a mile, including all expenses.

And now, with the advice-giving session about over (maybe you won't pay much attention to it, good as it is) we'll let you pitch into the section of the *Manual* that you're eager for — the chapters showing you *how* to build the particular plane you've set your heart on. With a fond parental feeling, we turn you over to the how-to-build-it section of the 1932 *Flying and Glider Manual.* • • •

among these is the Ford Model A, used on the Pietenpol Air Camper. New engines of this type can be purchased for between $125 and $200, depending on whether you get a new job from the factory, or succeed in picking up a bargain from a wrecked car in which the motor is intact. If you are not familiar with engines, have a competent mechanic do the conversion job for you. At all events, you will have to learn about the motor you use, sooner or later, in order to make necessary repairs, so make up your mind to study the subject thoroughly.

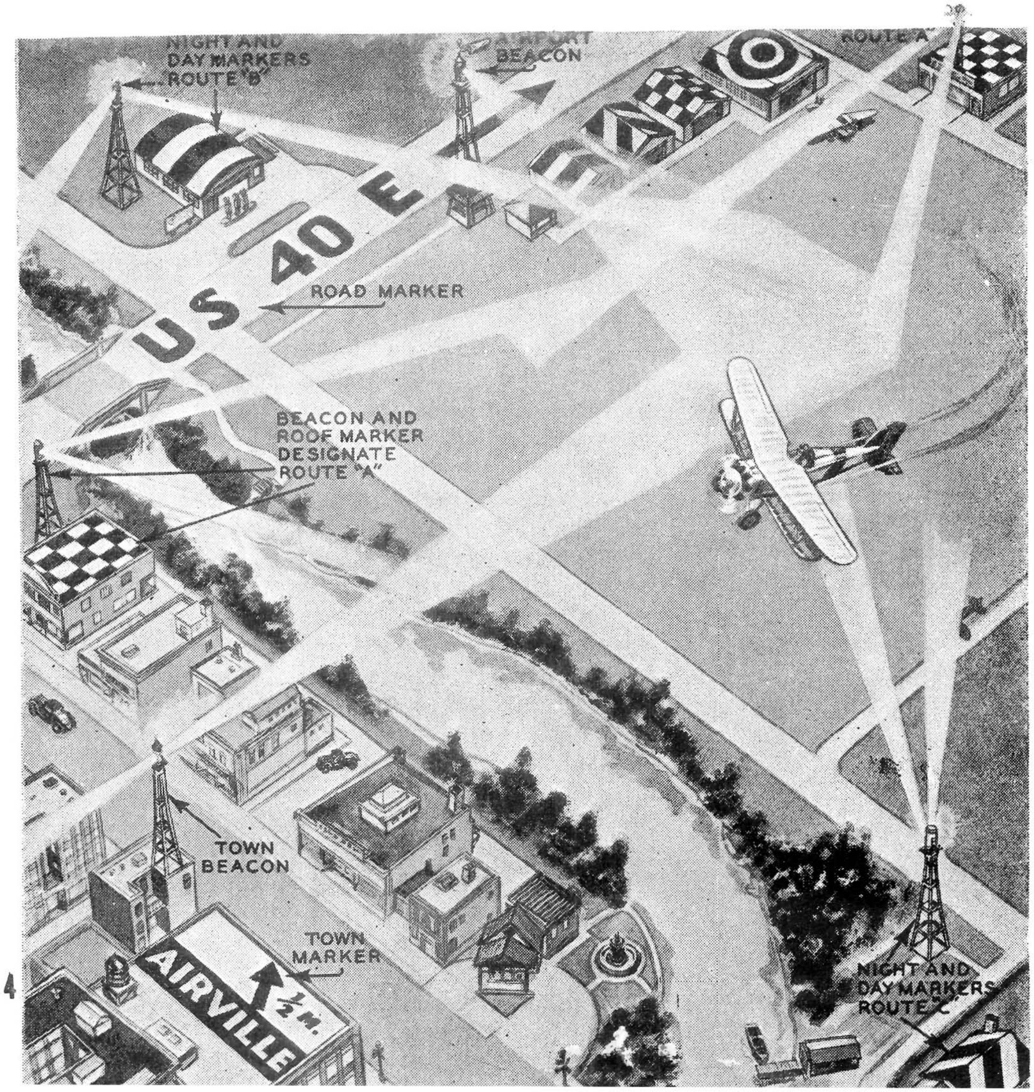
An air-cooled motor, designed around the Ford Model A, has recently been developed by the Globe Tool & Engineering Co., Dayton, Ohio. They furnish this job in both upright and inverted types. The inverted motor develops 60 hp with a Stromberg aviation carburetor, and 52 with a regular Ford carburetor, making it amply powerful for such a ship as the Pietenpol Air Camper.

Other reliable motors which the amateur may use are the Heath Henderson, standard engine of the familiar Heath Parasol sportplane, the Continental A-40, and the Aeronca. Chevrolet motors have likewise been converted for biplane use with good success. Outboard motors of the Johnson Seahorse type, developing around 32 hp, have won favor with some sportplane builders for their good performance. The Seahorse is usually used to power single-passenger planes. Motorcycle engines of the two-cylinder V-type have succeeded in getting sportplanes into the air, but as a general rule they do not have sufficient reserve power to afford a desirable factor of safety.

Once you have built your sportplane, it must be test flown. If you have already taken flying lessons, you can hop it yourself — if not, entrust the job to a competent pilot. He'll put it through its paces and find out if there are any "bugs" that need correcting before the plane goes into active service. Usually there will be a few minor corrections which must be made before the plane performs perfectly. The center of gravity may be too far forward or back, and must be corrected by shifting weights. A handy method of testing for the center of gravity is to balance the plane on a sawhorse.

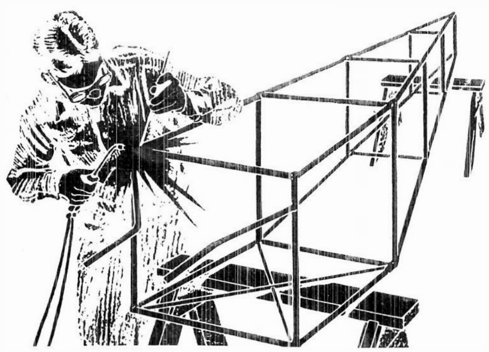
When the plane is performing to your satisfaction, take it up (always assuming that you've had at least 10 hours flying instruction, and have soloed a ship before). You'll soon get the "air feel" of this new machine you've built, and you'll know the thrill of pride that comes to every good craftsman in his handiwork.

If possible, you will want to get your plane licensed. The licensing situation changes so rapidly that it is impossible to tell you exactly what specifications your ship must meet. Federal regulations



Airplane builders flying their own ships are vitally interested in airport design. This drawing illustrates a proposed system of marking, whereby certain air routes will be designated by various color combinations and designs painted on the tops of buildings along the way. The pilot would thus be able to keep on his course without difficulty.

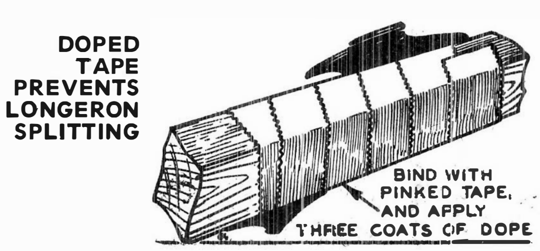
Do *not* try to teach yourself how to fly. Take dual-control lessons under a competent pilot; better yet, enroll at a recognized aviation training school. It is perfectly true that the Wright brothers, and many other early flyers, taught themselves how to fly. But it is also true that the ships they flew in were slow, low-powered, and there was much less risk of life and limb than is the case with a modern plane. Amateur builders have written in to us occasionally, reporting that they successfully soloed a homebuilt plane without previous flying training. Others have written in, enclosing photographs of wrecked ships, with propellers and motors smashed and wings hopelessly crushed — and they, too, have reported their experiences in soloing a plane without training. Their motto is



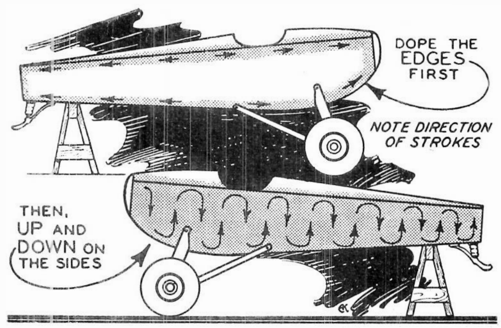
invariably "never again — until I've taken lessons and know *how* to fly." It's not worth the risk of destroying a sportplane on which you have labored for months for you to try to take it off the ground without having had flying experience.

Flying courses these days are reasonable in cost.

Now, let's get back to some of these homebuilt planes whose pictures appear here. Study them — note that the designs are in many cases original, though following time-tried principles. There is nothing freakish about them. Of course, the ama-



One bugaboo of wooden construction is the mental hazard one has to hurdle of seeing his innards poked full of splinters in event of a crash. One way to minimize the danger of the split longeron is to bind the thing so tightly with tape that a double layer of cloth covers the member. Then dope will shrink the fabric so taut that in the event of a fracture the break will be confined to the immediate point of stress, and no splintering will result. The break will be square and clean.



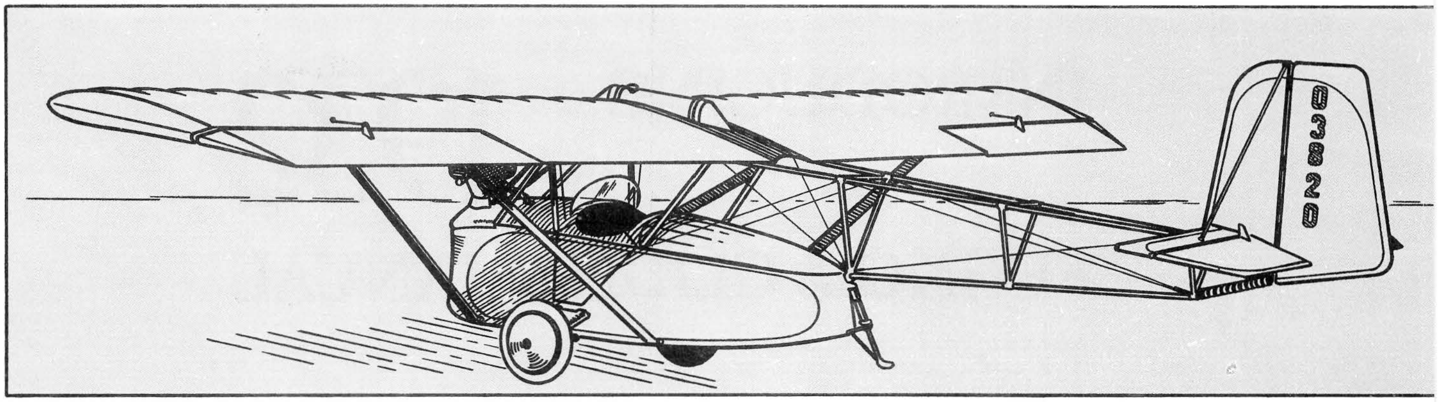
Here are a few tips on doping for the airplane builder. The drawing shows how the edges of the fuselage fabric should be doped first, then up and down the sides, to avoid wrinkling.

teur builder is perfectly free to construct a freak plane if he is confident it will work — many amateur builders are working along unconventional lines. But for the builder who simply wants a dependable airplane, and who is not concerned with experimental work, we emphasize this advice: follow the plans as presented in the *Manual.* Any change is bound to affect the performance of your ship. The shifting of any part, the shortening or lengthening of certain dimensions, will move your center of gravity to a spot other than that intended by the designer. If you have studied airplane designing enough to have confidence in your alterations, go ahead — you may even improve on the original design. But don't blame the plans if you make changes in them and are then dissatisfied with the results.

In setting out to build your plane, remember that the better equipped your workshop, the more satisfactory the finished job. On another page of this volume appears a detailed article on equipping the home workshop, giving you pointers on the necessary tools and apparatus. We therefore need not go into detail here, except to remark that there is a certain number of tools that are absolutely essential — planes, chisels, screwdrivers, hammers, glue clamps, etc. Such extra pieces of large equipment as lathes you will find extremely helpful. Any of the more popular home workshop outfits, which can be purchased for around $75, will come in mighty handy and make a permanent addition to your shop.

In building your plane, don't be penny wise and pound foolish. You save very little by substituting inferior lumber for regular airplane spruce, for example, and your plane won't be nearly so sturdy when built of inferior stuff. It is best to buy your material from a reliable airplane lumber and supply house. It may be possible to pick up bargains now and then around your local airport, and if the bargain is a real one, take advantage of it — but be sure of what you are getting.

The motor of your plane is its most vital part — do not skimp on it. Various engines have won deserved popularity for lightplane use. Notable

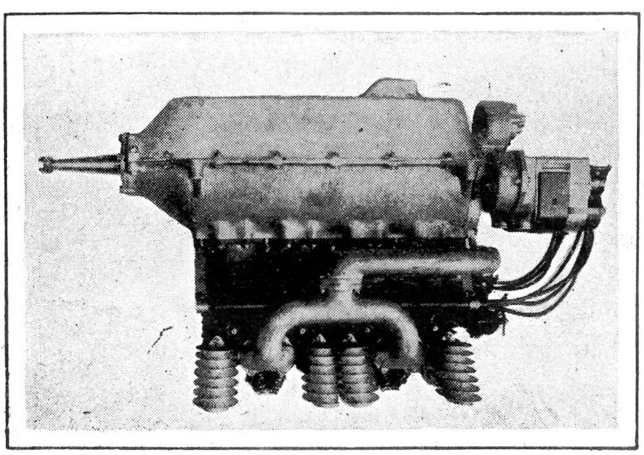


The Ramsey "Flying Bathtub." Plans for building this unique lightplane appear on page 60.

THE AMATEUR AIRPLANE BUILDER

The building of your airplane is the finest way in the world of getting into commercial aviation. This chapter presents practical information which will help the amateur airplane builder toward his goal, shows him how to avoid costly mistakes, advises him to learn flying at a recognized school or under a competent pilot and gives pointers on the equipment of his workshop.

Can the amateur airplane builder successfully construct a light airplane which he can depend on to perform reliably in the air — and having constructed it, can he learn to fly it and use the knowledge thus acquired as a stepping stone to a worthwhile job in commercial aviation?



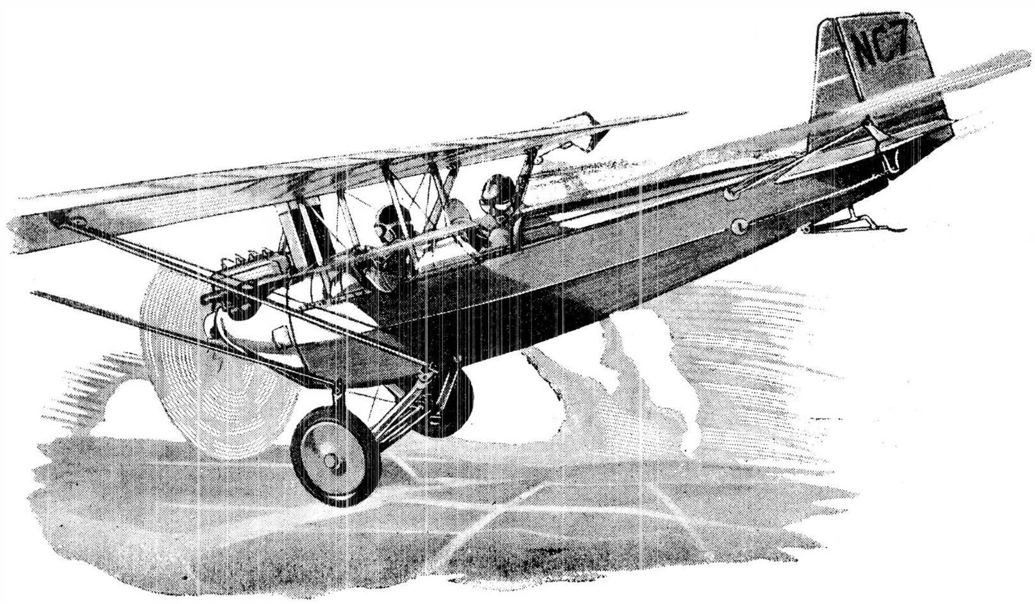
Inverted airplane motor built up around Model A Ford parts.

Well, in the words of the comic strip comedian, "you should esk!" Although the editors have always been convinced that there is a tremendous number of young men throughout the country who are building their own airplanes, they see proof often that the amateur airplane builder is a *good* builder — that his product takes no back seat to any factory built ship in the sportplane class.

Furthermore, amateur airplanes *fly*, and fly successfully, safely, dependably. And in flying them, the amateur pilot piles up hours of flying time which will prove mighty helpful to him when he's applying for a transport license. He learns the "feel" of the air, learns to judge the nature of the country below him in picking out landing fields, learns what can be expected of an airplane and what cannot.

Just a word of caution is appropriate here.

INTRODUCING the 1932 FLYING & GLIDER MANUAL



When the first edition of the *Flying and Glider Manual* was published three years ago, it was inspired by the belief that thousands of young men throughout the country were intensely eager to own and fly their own airplanes, but that the excessive cost of purchasing a factory-built ship made realization of their dreams impossible. By the publication of reliable plans from which the amateur could construct a dependable light airplane at a moderate cost, the *Manual* hoped to help these men realize the ambition closest to their hearts.

That the *Manual* filled a real need was proved by the immediate success of early editions. Today there are hundreds of sportplanes in active service, delivering countless hours of flying time to their owners, which were constructed from *Flying and Glider Manual* plans. The description, "The Sportplane Authority of America" was given to the *Manual* by the thousands of enthusiastic readers who have found it to be a source of information which they could procure nowhere else. It is part of our service to answer technical questions which may occur to you during the process of building a sportplane.

In this, the fourth, or 1932 Edition, of the *Flying and Glider Manual,* the aims and traditions of previous *Manuals* have been carried on. The editors believe that this volume is more crammed with practical information for amateur airplane builders than any which have preceded it. Join the army of *Flying Manual* sportplane builders by starting construction on one of the fine planes contained in the following pages. •••

Experimental Aircraft Association

EAA brings back the 1932 Flying and Glider Manual A Historical Development of the Home-built Airplane

The old Flying Manual of yesteryear was a great inspiration for many of us and in our opinion caused many of the leaders in aviation today to get "their start." The pages of interesting stories, how-to-do articles and complete aircraft plans can be considered a great contribution to our present family type airplane.

Over the years EAA Headquarters has received many letters and requests to either reprint or locate old Flying Manuals. With this urging in mind, and with the concurrence of Fawcett Publications, we are reprinting these famous series.

These old designs in many instances lack the technical progress made between the early thirties and today, however the Experimental Aircraft Association Air Museum Foundation is presenting them both as a historic and educational publication.

We hope that these early day aviation publications will serve to stimulate the reader toward light aircraft design improvement and to play an active part in EAA's effort to improve the airplane for the "Little Guy."

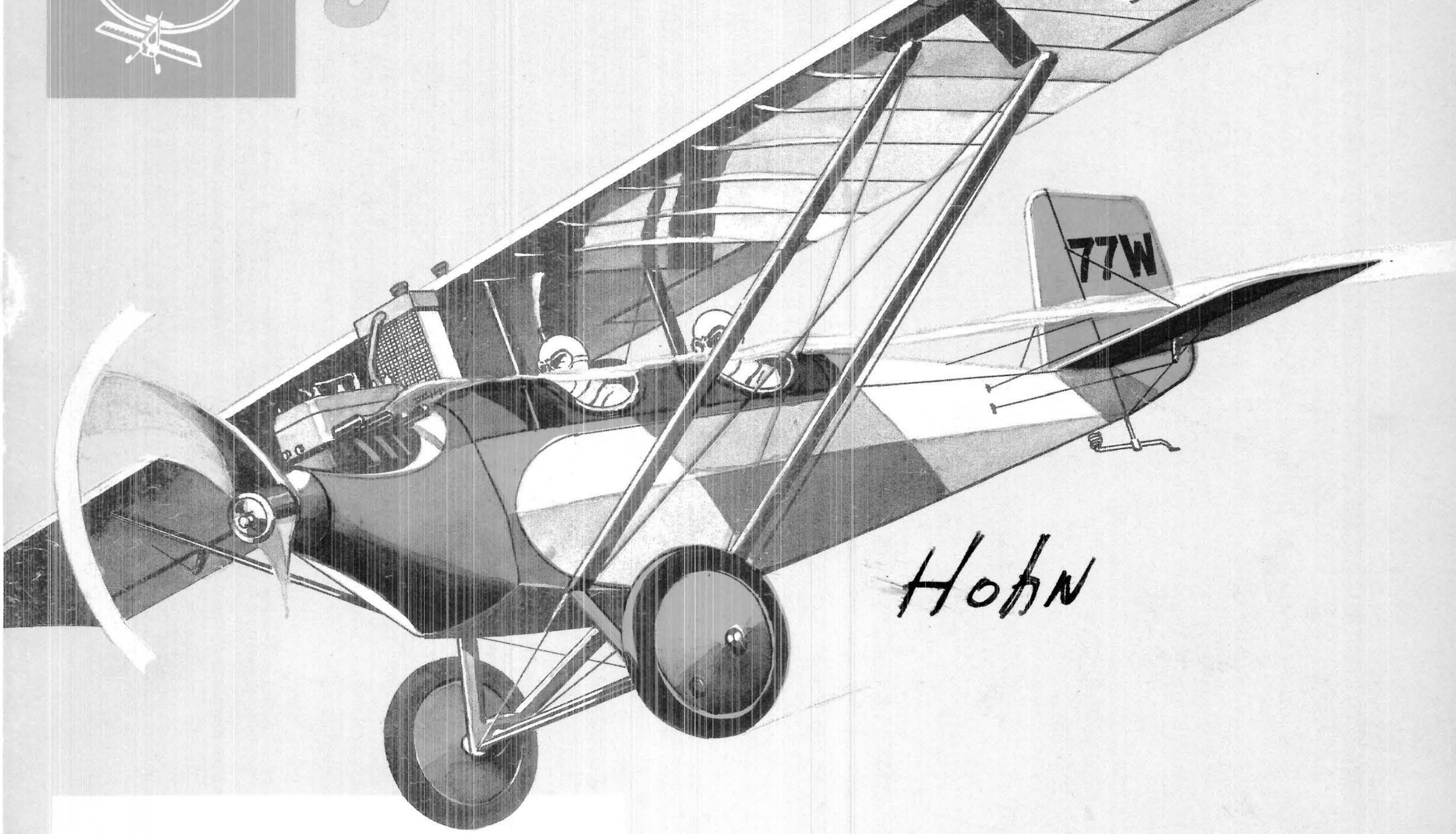
PAUL H. POBEREZNY
President, EAA
Air Museum Foundation

Prepared by
PAUL H. POBEREZNY
and
S. H. "WES" SCHMID

1932

EXPERIMENTAL AIRCRAFT ASSOCIATION

FLYING and glider MANUAL



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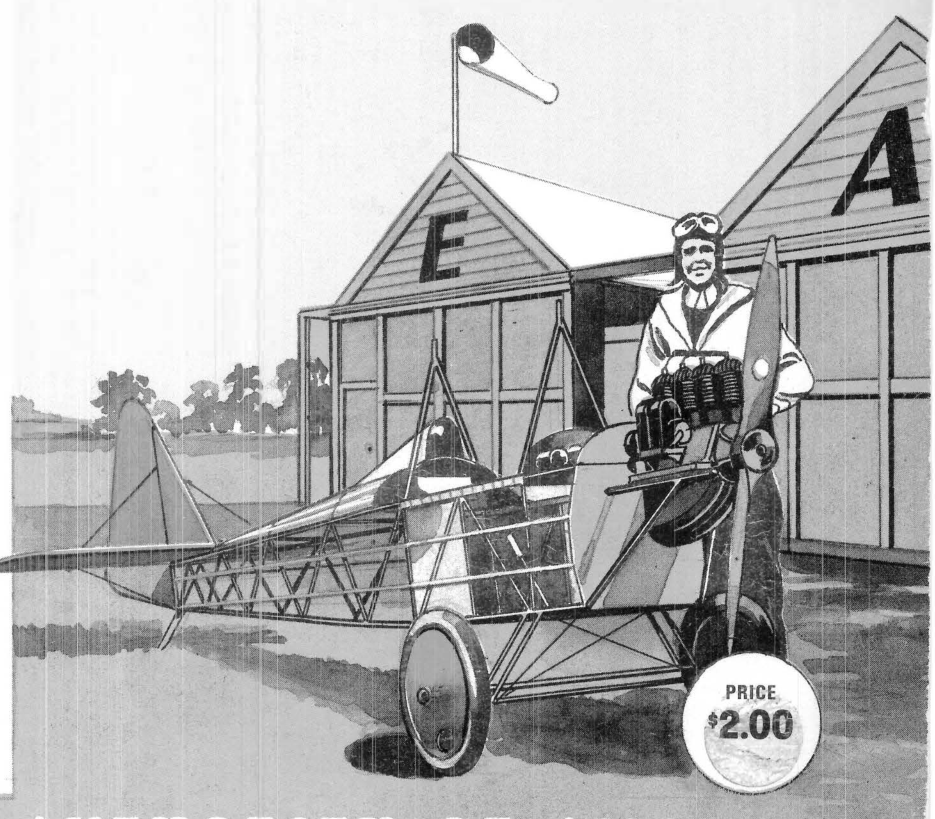
BUILD and FLY

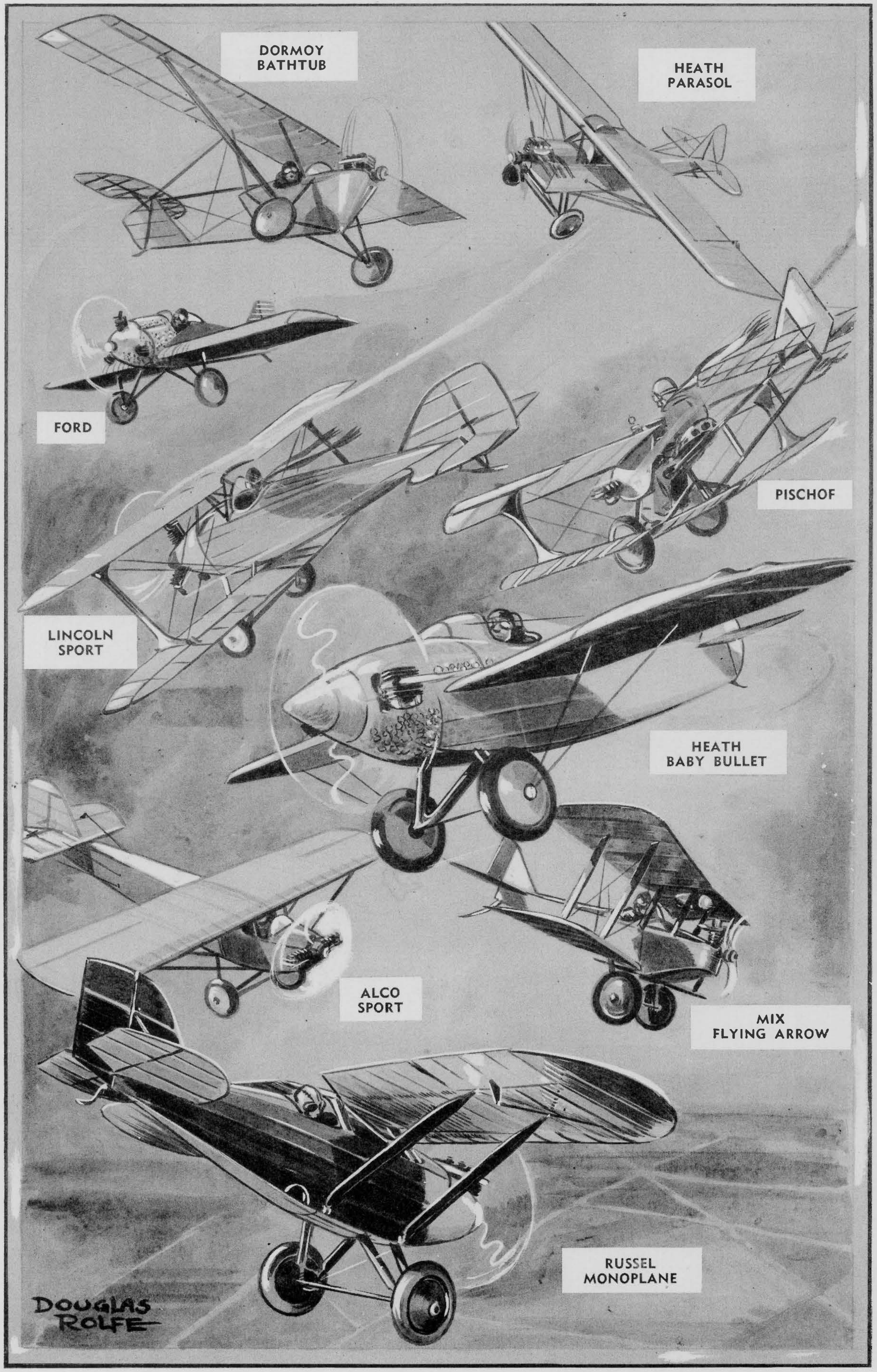
CONTENTS

COVER DRAWING BY
DOUGLAS ROLFE

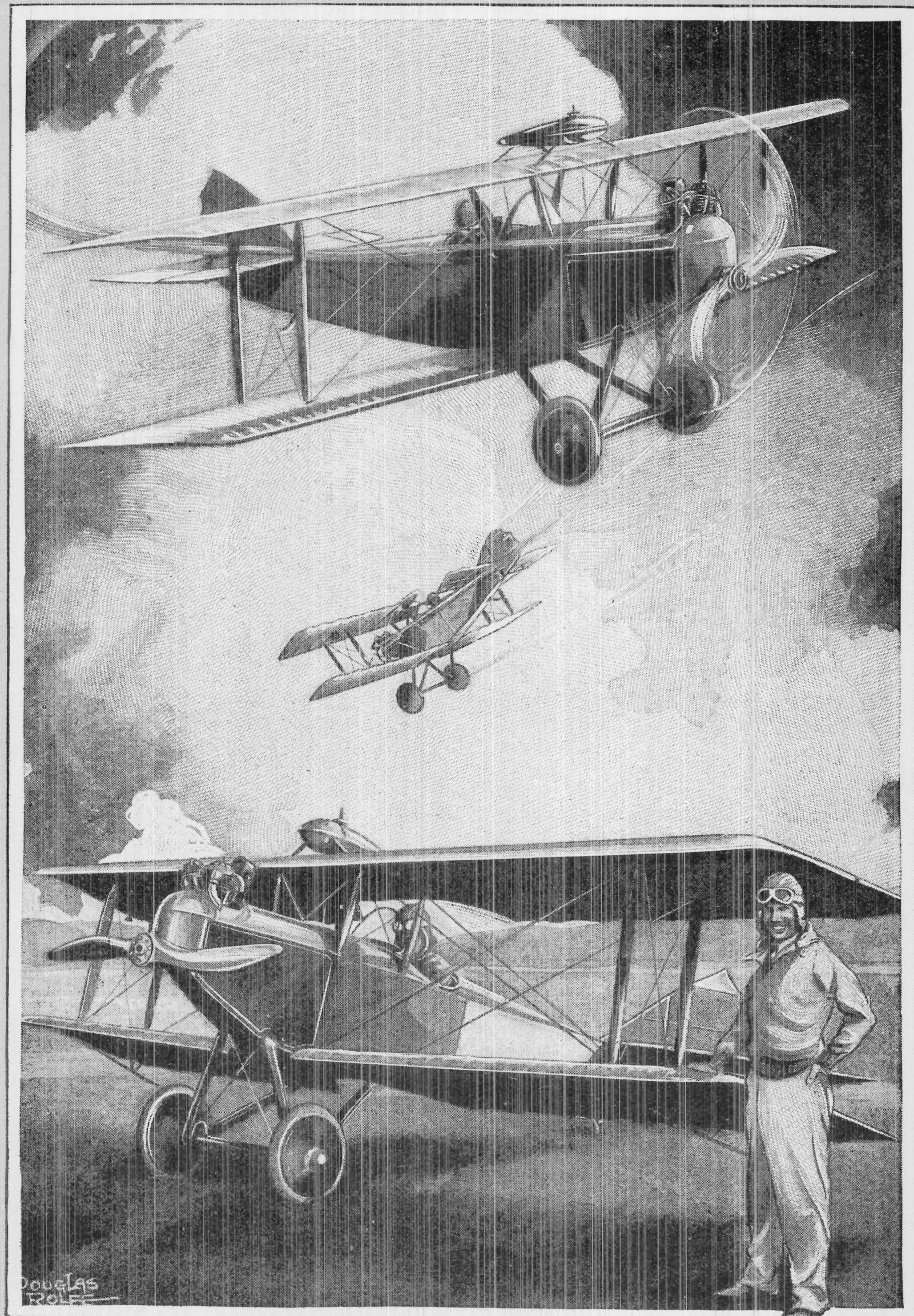


PRICE $2.00

THE SPORTPLANE AUTHORITY OF AMERICA



This drawing shows the types of lightplanes the Flying Manual is presenting to eager, air-minded young America. Complete plans for several of these ships are included in this issue.

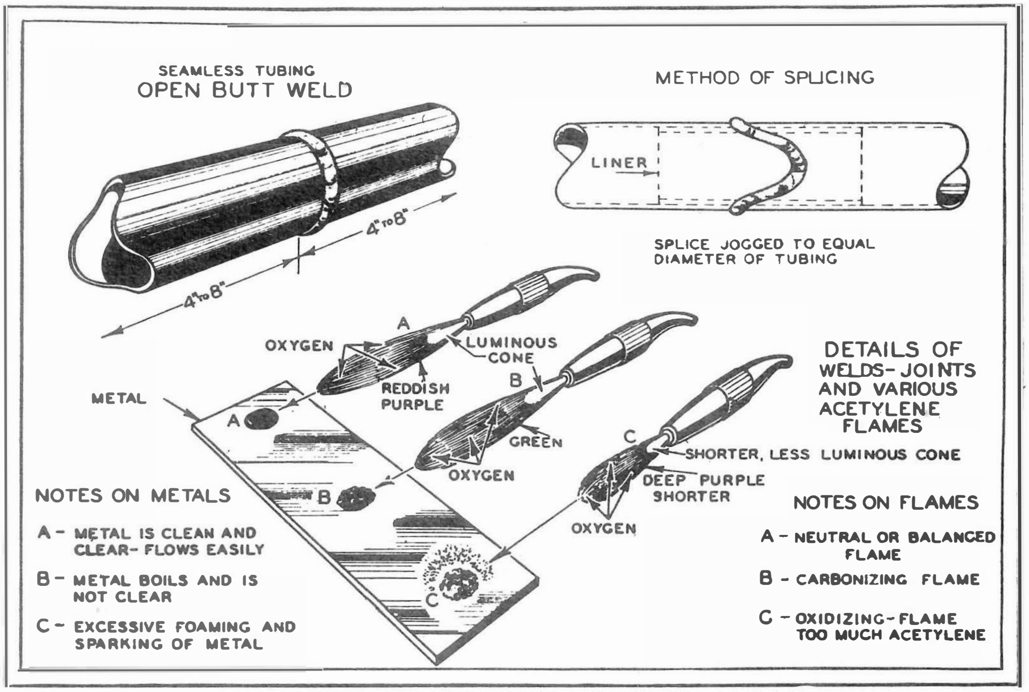


The plane shown left, powered with a geared down Indian, is the plane for which the fittings in the article on page 6 were designed.

FLYING AND GLIDER MANUAL, "The Sportplane Authority of America", 1930 edition, was originally published by MODERN MECHANICS AND INVENTIONS, A Monthly Magazine of Science and Invention/FAWCETT PUBLICATIONS, INC., Minneapolis, Minnesota.

EAA AIR MUSEUM FOUNDATION, INC.
Franklin, Wisconsin

Acetylene has a lot of carbon in it; if the flame is not exactly right, burning equal amounts of oxygen and acetylene, the metal will carbonize and become brittle. Too much oxygen will result in scaly, cracked weld. Too much acetylene will carbonize the weld and make it fragile.



of mild steel in order to gain rigidity. In other words, we do not want the weld easy to bend. The rod must be clean and free from impurities. No welding should be done without the proper welding rod.

The welding rod should be brought into contact with the metal and with the flame playing on the metal of the weld and on the rod at the same time a portion is melted off and fused to the weld with the circular torch motion.

This motion or circular movement of the torch seems to leave the metal in a series of overlaid concentric circles. This, if done as shown in the accompanying photos of welds executed by a skilled Travel Air craftsman, is generally an indication of a good weld having good penetration.

Regularity of the waves on metal of ordinary thickness is the mark of the good workman.

Unlike most other ferrous metals, steel does not become very fluid and there is little danger of collapsing a weld unless the gases are rushing from the torch at too great a speed. The torch should not roar, a barely audible whistle will burn enough gas generally to do the trick. With steel, the metal cannot be puddled, and the flame must come into direct contact with the part to be fused.

With mild steel there is the slightest of sparking. The sparking increases as the thickness of the metal increases and as more heat has to be applied.

Excessive sparking is an indication of burning and the operator may detect the oxidizing or burning flame by the size and character of the sparks. Those from the oxidizing flame break as they fly, like sparks from a Fourth of July sparkler, while with a properly adjusted flame there is no "break" — they fly off into space retaining their shape until the air cools them and they are lost from sight.

If the flame is not properly adjusted, the weld will usually foam. This foam will be in a circle surrounding the flame. Too large a flame will also cause oxidation, and particularly with steel, the flame must not be played on the metal after it has been bonded. Melting the material in the rod, and allowing it to drop on the weld is still another cause for an oxidized weld, which is another way of saying a poor weld. Once again let me say that the rod should be in contact with the weld so that the heat conducting properties of the metal will prevent excessive burning as the rod is melted.

Good and economical welding is best achieved by having the torch in about a 30 to 45 deg. line with the weld, working toward the unwelded section. This method takes advantage of the heat in the flame envelope for pre-heating the work immediately following. •••

The "Fly", built by members of the Aviation Corps at Kelly Field, Texas, has a wing spread of only 18 ft. Powered with a 3-cylinder radial air-cooled motor of 60 hp, it develops a speed of 115 mph and has a cruising radius of 500 miles. It is a one-man plane carrying only the pilot. The plane comes only to the average man's head, as is shown by the photo in which Lieut. D. Phillips of Kelly Field is standing alongside the tiny ship. It is one of the smallest biplanes on record.

can cleanly puddle the metal.

Now, in welding aircraft material, bear in mind that the technique with the light steel thicknesses used is different from that used in welding cast iron parts, etc. Usually a welder who has had experience welding castings, either in iron or steel, has too heavy a hand to make a good airplane welder. In airplane welding, the slightest variation from neutral flame, or from proper tip size, or from clean fusion may be disastrous. In the welding of castings plenty of heat must be employed. In the welding of airplane tubing just the right amount of heat must be used.

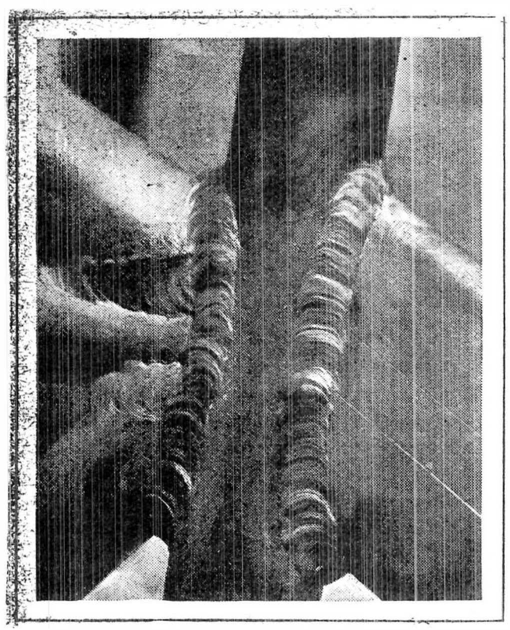
As an illustration of what I mean, take this: Often a 3/16 in. gusset or turnbuckle lug must be attached by welding to .050 in. tubing. This is done, of course, by playing the flame on the larger piece, bringing it to heat, and then occasionally playing the heat on the lighter stuff to gain an even distribution. In castings the idea is to get the metal melted and filled — recast.

With the proper technique of flame maintenance mastered, the next thing is to consider the materials on which you are going to work.

Chrome molybdenum steel, on account of its toughness, and low carbon steel, on account of its uniformity, strength and ductility, are the two types of steel used in most aircraft production. Steel of low carbon content may be easily welded; steel of high content is extremely hard to weld.

Now, since a weld cannot be as strong as the original material, because the weld is not subject to heat treatment, rolling, etc., the weld simply being a recasting of the metal, with low carbon steel we can closely approach the strength of the original metal; with other types of steel we cannot.

Steel low in carbon is very ductile — it bends or twists quite easily — but as we increase the carbon, the metal becomes harder and more brittle, less than one percent of carbon representing the difference between high and low carbon steel. In this connection let me say that the carbon content of aircraft parts may be largely determined by their duty. A stamping such as a fuselage part might best be of low carbon steel, or as the metal is more commonly called, mild steel.



Here's an example of good welding. It is part of the Travel Air fuselage. Note how beautifully the metal has been flowed by the acetylene toroh.

Complex welds like this, disposing of loads from six or seven directions, can be made by welding.

The landing gear, on the other hand, being subject to severe shocks, is hard steel. Generally the work done by the metal fittings is between these two extremes and the material used is known as half hard steel.

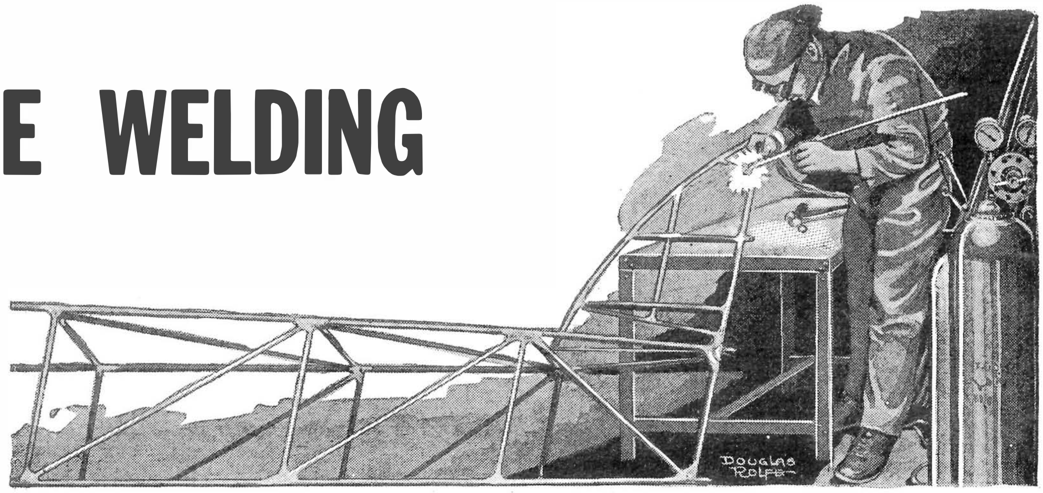
As an example of simple welding procedure, let us take two pieces of tubing and put them together. Make sure they are clean and free from grease or paint. If they have been welded previously cut off all the old weld. No further preparation is necessary as long as the edges have been butted together.

Adjusting the flame properly, the torch is brought until the end of the flame nearly touches the metal. It is moved slowly until the metal each side of the weld for a distance of about three thicknesses of the material is at a red heat. Then the cone is brought in direct contact with the butts to be welded, the tip of the cone just touching the metal. Steel is the only metal in which the cone should be brought into actual contact with the metal. It should not be brought so close that the cone bends and spreads on the surface. Since the hottest part of the flame, by several thousand degrees, is just at the tip of the cone, the end should just lick the surface. By a short circular motion, the cone always at the same distance from the metal, the two edges are flowed together and the torch comes back to the original starting point.

With thick metals or with a weld which has considerable gap, welding rod should be employed.

Undoubtedly the ideal rod from the workman's standpoint is the commercially procurable Swedish, or pure iron since it is free from impurities and welds easily. However, for most aircraft work it is too ductile, and it is better to use a rod

AIRPLANE WELDING



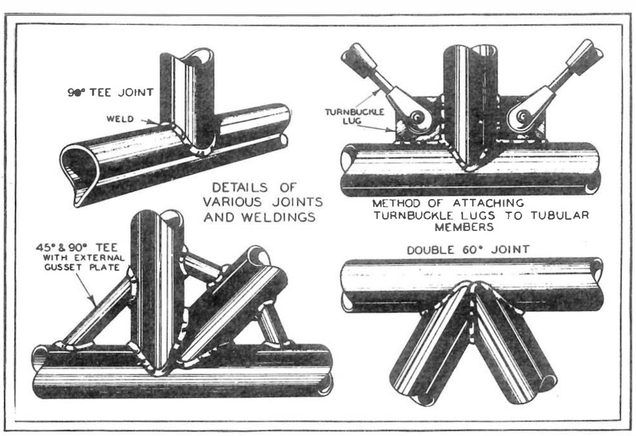
A good airplane welder is one of the types of workmen most in demand in airplane factories. Welding is something of an art, and can be learned only through actual practice. Any man with good eyes and steady hands can weld. This article explains the fundamentals of welding practice.

Welding is a process of joining metals by fusing them.

Due to the peculiar action of metals, intimate knowledge of how they act under heat from the oxy-acetylene flame must be gained before good reliable welds can be made.

We will start first with an explanation of the flame. The fuels used in welding by the oxy-acetylene process are oxygen and acetylene. These gases are blended in the proper proportion by means of the torch. The torch proper is equipped with two valves which control delicately the amounts of oxygen and acetylene admitted to the tip of the torch from the respective drums of acetylene and oxygen.

These drums are commercially procurable from any wholesale supply house. The user pays a deposit on the drum and pays for the gas. One drum of acetylene and one drum of oxygen are connected to the torch by separate rubber hoses. Special directions accompany the connecting of the hoses and pressure gauges and will not be dwelt upon here as the variety of gauges is quite varied.



Typical of usual practice in welding are these joints. One is a plain tube to tube joint, another has gusset plates in the form of small tubes, another has turnbuckle lugs joined with thinner tubing.

Acetylene is C2 H2 and contains 12 parts carbon to every part of hydrogen. To make it burn properly oxygen is fed to it. This process of combustion produces heat 6,000 deg. F. Because it is high in carbon content, enough oxygen must be admitted to the flame to completely consume all the carbon. Otherwise the carbon will combine with the molten metal and make it high carbon steel, of uncertain carbon content, which is always very brittle and subject to fracture.

The first thing then is to perfect the flame you use in welding. The flame diagram on the following pages will give a good idea of what a perfect flame is like. After the proper size tip has been selected and screwed to the torch (tips vary in size in the amount of gas they can burn to produce various sized flames) the acetylene is turned on gently. It is lighted with either a match or one of these sparkler lighters furnished to welders. The tendency will be to get the flame too long. Valve it down so that it is about 3 in. long. Then turn on the oxygen, slowly. This will draw the flame down.

The thing to watch is the luminous cone in the center of the flame. This will burn green. If there is too much oxygen the flame will have no long soft purple foxtail. It will be short and the central cone will be bright, round and short. This flame is to be avoided because it is an oxidizing flame. It will make the metal scale and this scale or oxide will weaken the weld a great deal, as it dissolves in the molten metal.

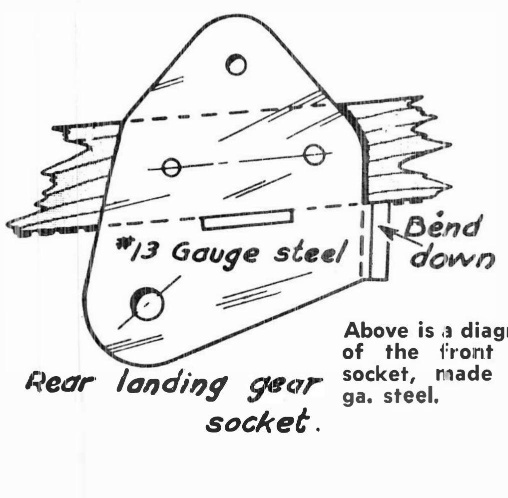
The so-called neutral flame is the flame to strive for. In it equal amounts of acetylene enter into combustion with equal parts of oxygen to produce a flame which has no oxidizing or carbonizing effect.

Such a flame can be recognized because the central cone has no tip. The admission of oxygen should proceed until the original acetylene tip on the central cone is being burned off. In this condition you will have a neutral flame, one which you

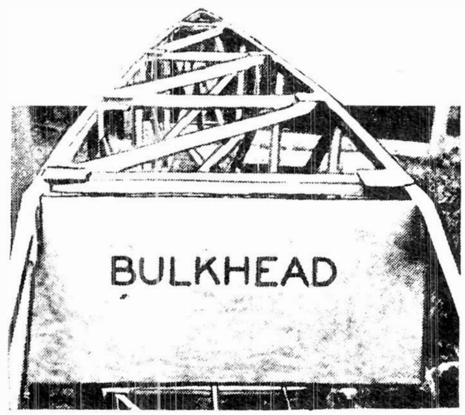
is done the wings are ready to sew. This is done with long needles with big eyes. Cotton warp is used. With the aid of a marking stick designed for the purpose, the cloth lying over each rib is marked with a pencil at 8 in. intervals, not sewing closer than 3 in. to the beams or within 6 in. of the trailing edge. Stand the covered wing up on its nose against a ladder or other support in such a way that each side of the wing is accessible to the sewers. The sewer on one side thrusts his needle through to the sewer on the other side, making sure that his needle point is close to the rib; the man on the other side draws the needle point through and passes it back through the cloth on the other side of the rib, at first sticking the point barely through the cloth, until told by his partner that he is on the pencil line. As soon as he gets it right, the man giving directions draws the needle through and knots it; the knot tied is not a full knot but just a sort of half hitch which is drawn tightly, then the needle is shoved through at the next lower point without cutting the string. The purpose of sewing the wing ribs is to make sure that the cloth will assume the shape of the wing section no matter how much wind stream there may be. This sewing is all to be covered with cloth tape about 1½ in. wide.

After the cut out places in the wings and fuselage have been fixed, the whole plane is ready to dope, since all the covering is now done. Use big whitewash brushes for applying the dope; do not attempt to brush it into the cloth, like you would paint; use the brush just enough to spread the dope, and prevent it from piling up in one place. If you intend to use a finish of paint, sandpaper the surface after the first coat has been applied; with the second coat the tape is applied to all tacked and sewed places, etc. It will be found that not nearly as much dope will be required for the second coat, and the amount needed decreases with the number of coats applied. Two more coats are then put on after suitable drying intervals; these last two coats should contain the pigment if a pigmented surface is desired.

The last thing to do before assembling the plane is to install the motor. Two shelf-like brackets support the engine, which is held in its position by means of steel straps around the bases of the two horizontal opposed cylinders. The Lawrence engine



Above is a diagrammatic view of the front landing gear socket, made from No. 13 ga. steel.



A bulkhead of plywood is placed in the fuselage, both for added strength and for fire protection.

is subject to a great deal of vibration, unless it is firmly mounted, but when installed properly makes a good engine for a small sportplane such as the Alco Sport Monoplane. Under favorable conditions it will carry the pilot and a passenger.

A Harley-Davidson 74 cu. in. motorcycle engine may also be used. The motorcycle engines can be bought for as low as $25.00 second handed, while the price of the Lawrance ranges around $100.00. A good Harley engine will develop between 12 and 16 hp. The chain sprocket on the crankshaft may be fitted with a thick metal plate held on with bolts, and the 5 ft. propeller may be bolted directly to this plate after it is suitably drilled for the propeller bolts. By using a reduction drive, by means of a jack shaft and chain, you can obtain considerably higher propeller efficiency, but the parts are somewhat more complicated. For a two to one ratio, use a propeller 6½ ft. in diameter and 3½ ft. pitch; these can be purchased for about $15.00. The direct drive propellers come somewhat higher, but they can be made at home by any handy man who will take the pains required.

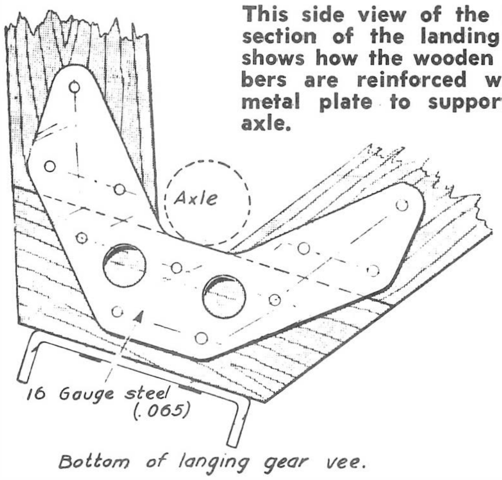
All covering done and with the motor mounting accomplished, the plane is ready to be towed to the flying field where the final assembly is to take place. The easiest way to tow a complete plane to the field is as follows: With the landing gear in place, and tires pumped up, the plane's tail skid is placed on the back end of a truck or motor car and held there by means of ropes. 2 by 4 boards are then placed under the longerons of the fuselage, projecting out a little, to form a shelf for placing on the wing. Tie the 2 by 4s to the fuselage, set the wing up on the shelf formed, (nose down, trailing edge up), then tie the wing firmly by passing the rope clear over the top, then down under the fuselage where it is knotted. It is best that one of the workers should ride on the back end of the car and see how the load is doing. The car or truck should be driven at a conservative speed.

Upon reaching the flying field, unsling the wing, and start mounting it and the tail surfaces upon the fuselage; these should have been previously fitted, so that nothing remains but putting nuts on the bolts through the fittings for holding the tail surfaces, wing brace struts, and wings, and then safetying everything for the test flight.

After this is done, assuming that the motor is tuned up and ready to go, the test flight is ready to begin.

The distances between the seat and the control stick and between the stick and the rudder bar should be adjusted before the stick and rudder bar assemblies are nailed to the floor of the fuselage. The distances most suitable depend upon the aviator's individual requirements, and can be easily determined by sitting in the plane and moving the stick and rudder bar until they are in the most advantageous position.

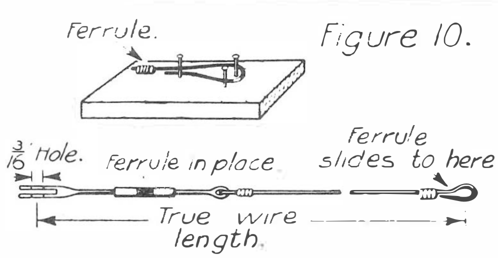
The pulleys for the elevator controls are Micarta, 2 in. in diameter, and cost 34 cents each. For the amateur who wishes to build his plane cheap, we suggest that he use window sash pulleys which will cost only a few cents each. The pulleys



This side view of the lower section of the landing gear shows how the wooden members are reinforced with a metal plate to support the axle.

may be mounted either above or under the floor board. If mounted under, a fairly large gap will have to be cut out of the floor to allow the cable to move when the stick is thrust sideways. The cable itself has one end fastening to the front hole in the collar fitting on the stick. A turnbuckle is used there as a means of adjusting the tension in the cable from time to time. From the stick the cable goes forward and down through the gap in the floor board to the single 2 in. pulley mounted on the under side. Passing around the front pulley it goes straight back to the guide pulley under the seat and back of the stick; thence back through the fuselage until in the fourth bay from the stern post, the single cable end is looped and two other cables joining on giving the split control effect. The two cables go to the upper elevator horns. Then coming back on the under side, two cables come from the lower elevator horns, join and make one cable, reversing the procedure, and thence go to the guide pulley under the floor boards and from there to the collar fitting on the stick again. A turnbuckle fitted near the stick serves as an adjustment of the tension in this cable.

The final step in getting the fuselage ready to cover is mounting the instrument board. This consists of nailing a piece of 1/8 in. plywood across from one center section strut to the other, and even with the pilot's eyes; of course, it is not absolutely necessary that the pilot have any kind of



instruments, but for up-to-date flying instruments we recommend an altimeter, an oil gauge, and a compass. A tachometer is needed, too, but the shaft is rather hard to attach properly to a motorcycle or other small engine. The instruments are mounted on the plywood dash board by sawing or drilling the right diameter for the body of the instrument.

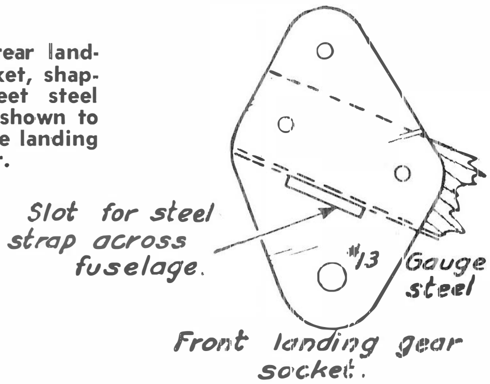
The fuselage is now ready to varnish and cover, even though the motor mount has not been discussed; installing the motor mount will not interfere with the other work.

It is not necessary to buy high priced special airplane fabric such as used in our large aircraft factories. For about 30 cents a yard you can get a good grade of cotton muslin such as "Pequot" at your local dry goods store. Lay the bolt of cloth on the fuselage top and sides and measure the distance needed, from the cabin, where the plywood sides end, back to the tail. Cut out four rectangular strips, two for the top and bottom and two for the sides of the fuselage. Where the fuselage tapers there will be considerable waste but this can be used to advantage later, either made up into tape or used where small scrap pieces are needed, on the wing corners, etc. Nail one strip along one fuselage longeron, then pull tightly and nail the other side; use "berry box" tacks which can be purchased from your local hardware dealer. The row of tacks will be covered with a long piece of cloth tape after the first coat of dope has been applied. The fuselage covering will have to be cut out in various places; the skid will project through one cut out place, and small holes strengthened by leather sewed around the hole will allow the control cables to emerge.

Covering the wings and tail surfaces: The cover for the wing is made in the form of a long envelope or sack, with one end and one side sewed up before slipping on. It is made to fit fairly tight; the pulling on of the cover is facilitated by the use of rubber gloves made of a ring cut out of an old inner tube; one man stands at each side and both men pull together, keeping the cloth even until it is pulled on as far as the wing butt. The side of the envelope is not sewed along where the wing is cut out for the aileron.

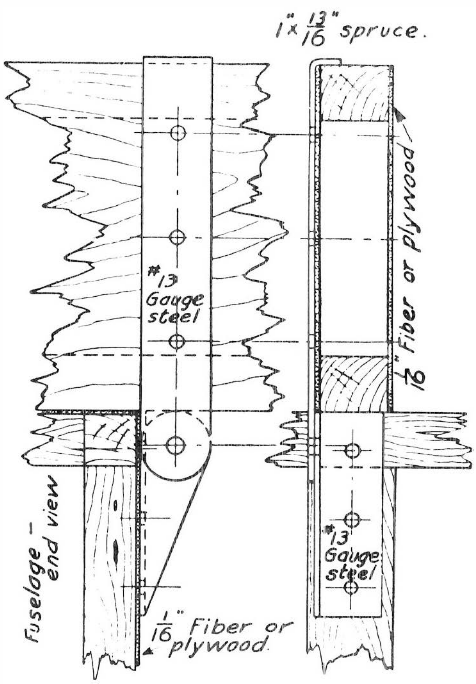
The envelope is tacked along the false beam for the aileron, and also at the butt of the wing. All tacks are covered up by cloth tape which is applied after the first coat of dope. After the tacking

This is the rear landing gear socket, shaped from sheet steel and bent as shown to receive the landing gear member.



been cut to length, and nail on the plywood gusset plates. After one or two of the cross members are in place, the work will commence to look like a real fuselage. The above instruction covers the work up to the bays nearest the nose. With the fuselage still in the jig, use temporary wires and turnbuckles to draw the lower longeron into the curve shown; then while it is held there, you can build up the front end, putting in the uprights and the short upper longerons running horizontal back to the heavy upright which also acts as center section strut to support the wing. (Only two such center section struts are needed, since the wing rests upon the top longerons of the fuselage itself back of the cabin). The heavy upright is 1⅜ by 13/16 in. spruce. Great care should be taken to see that it is put in firmly. Finally nail the plywood bulkhead in place. During spare time or when your work elsewhere is held up temporarily, give the entire fuselage a couple of heavy coats of a good spar varnish.

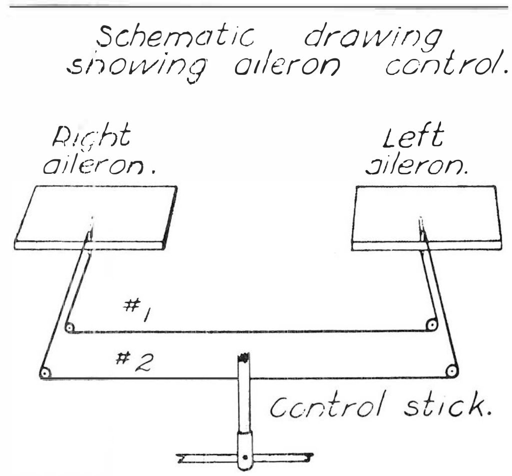
Installing the seats and controls: The drawing



This is a detail of the fittings which secure the fuselage to the wings. No. 13 ga. steel is used.

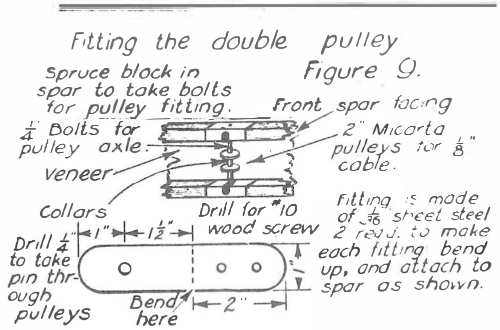
above shows how the rudder bar, and control or "joystick" are made. A simple one-piece fitting cut out from 1/16 in. sheet metal and bent to shape makes a good universal joint, allowing the stick to be moved in all directions. A universal joint from a Ford car may be used as the socket for the stick if you have any trouble making the one shown in the sketch; however, it is a little heavy, so we do not recommend it. The stick itself may be either cut from a broomstick or made from 1 in. steel tubing. It is drilled to take the collar fitting upon which are fastened the elevator and aileron control cable ends. The lower part of the stick is also drilled for the bolt which holds it to the universal joint fitting, and upon which the stick turns when it is moved fore or aft by the aviator. The sideways motion which is necessary for the operation of the aileron in such maneuvers as banking, is obtained by the universal joint turning upon the U-bolt through the wooden base. The stick assembly is held to the floor of the fuselage by means of long finishing nails.

The seat used is made of wicker, and is very

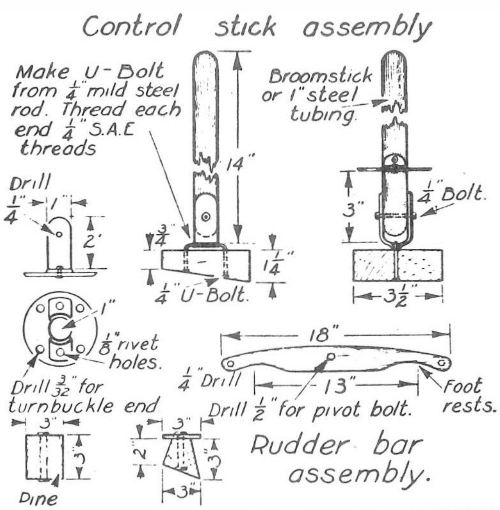


Sketch view of method by which the ailerons are controlled through wires attached to control stick.

light. They do not cost very much and are more satisfactory than a home made one, although one of the latter can be made from plywood. The seat is nailed to the supporting bridge in the floor of the fuselage so that the center of gravity arrow will pass directly through the body of the aviator sitting upright in the aviator's seat. If the plane is to be built as a two-seater have the passenger's seat close behind that of the pilot; the passenger will have plenty of leg room around the sides of the seats ahead. The reason for arranging the seats this way is as follows: A plane with a narrow fuselage will always out-perform one with a wide fuselage, everything else being equal, on account of the smaller wind resistance. If a plane was built as a side by side job, the width of the fuselage at the seats would have to be about 35 in., whereas with the tandem seating arrangement, the fuselage is only 24 in. wide at the widest point.



This diagram shows the method of attaching the aileron control pulleys to the front spar.



Details of control stick and rudder bar assembly are shown above with complete dimensions.

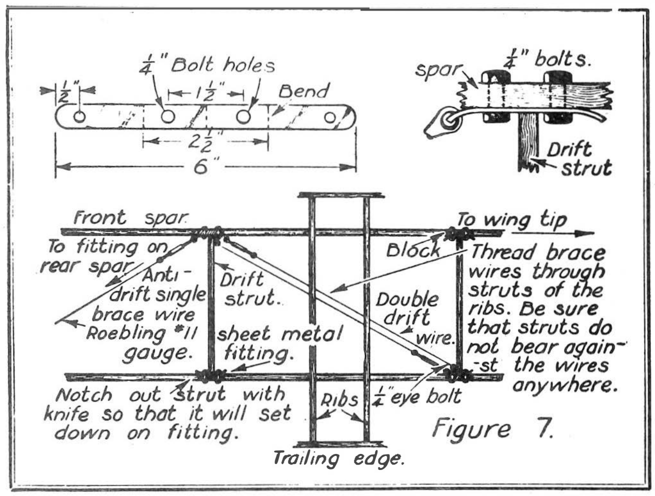
up. Beginning from the fourth station from the rear, and continuing on forward, the lower longeron is curved pretty sharply, and care must be used to see that you get the proper bend. Check by measuring the bend at different points in the most curved part of the longeron. The left side of the fuselage will not be quite the same as that on the right, since it is cut down at the cabin to provide easy access for pilot and passenger. Put in all the struts and tack on 1/8 in. two ply plywood from the cabin forward to the motor mount. Use a heavy tack about 5/8 in. long for the work, and use plenty of casein glue in addition.

After the left side of the fuselage is done, start work on the right side.

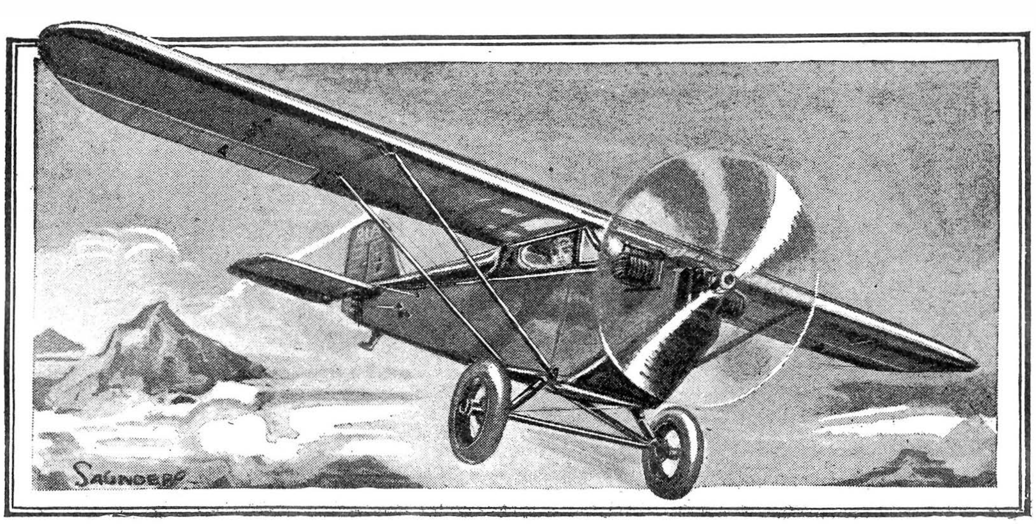
The next thing to do is to make some sort of a jig to hold the sides of the fuselage upright at the proper distance apart at all stations while the horizontal members of the fuselage are fastened in place.

A long low bench comes in very handy; on this bench nail cross pieces about 1/2 in. by 3 in., with the narrow side down. There must be a cross member at each station of the fuselage. After these are nailed down, cut notches the exact size of the upper longeron at that point at each end of the cross member mentioned; starting at the stern post, which is the common vertical strut for each side of the fuselage at that position bend the sides into position, as fixed by the dimensions shown on the plan view of the fuselage, and push the upper longerons into their positions in the notches cut for them. See that they fit snug and that the distances across the fuselage check the blueprint dimensions at all points.

When everything is in alignment, put in the cross struts of the fuselage, which have already



The method of internal wing drift bracing is shown in the diagram above. Only one-half of the system is shown.



Up aloft, ready to go where you will! This drawing of the Alco Sportplane shows the ship equipped with a 2-cylinder opposed Lawrence engine. In adopting the Lawrence engine, which is no longer manufactured, a two-throw crankshaft is substituted to cut down vibration to a minimum.

to the foremost vertical struts of the aileron ribs by means of $\frac{3}{4}$ in. nails.

As shown in the drawing, the wing tips and aileron tips are made of $\frac{1}{2}$ in. steel tubing. Bend it to about the shape shown in the blueprints, cut it to length, and attach at the aileron beam, (tapered at the end). To get a good joint at the points of attaching, cut away half of the steel tubing at those places, flatten it with a hammer, and drill it in two places to take a good sized nail which will be driven into the beam in front and the junction of the last rib and the trailing edge in the rear.

The aileron beam extends 4 in. beyond the last rib; seven aileron ribs are needed for each aileron. The one in the middle of the aileron should have a special block in it near the beam so that the aileron horn may be firmly attached. All control hinges are made as shown.

Making the drift or compression struts: These are the members holding the spacing of the spars against the pull of the wing brace wires. They are 28 1/16 in. long, $4\frac{3}{4}$ in. deep, and $\frac{1}{2}$ in. wide, and made of spruce. They are notched at each end, so that they will straddle the fitting where the brace wires are attached. In a future installment they are shown fastened to the insides of the wing spars.

Building up the spars: The wing rib for the Alco Sport Monoplane is so designed that the two spars are of equal depth. Make the rear spar 25 ft. 10 in. long and the front spar 25 ft. 4 in. long. The difference in length is explained by the fact that steel tube wing tip is curved and it must be fastened against the end of the tapered beams. Some of our builders who are somewhat cramped for room prefer to build the wing in two parts, a right and left panel, then join the panels to the center section 24 in. wide which makes the total span 26 ft., the same as if the wing were made all in one piece. In either case, the under side of the 24 in. section of the wing is not covered, in order to allow more head room for the aviator. The spars used are of the box type, using stringers of spruce 1 in. wide and $\frac{3}{4}$ in. deep. Of course, these will have to be spliced once or more if the wing is made in one piece. However, this is not very hard to do; simply join the butt ends, and nail to a heavy block placed at that point. Do not splice the plywood and the stringers at the same place or else the spar will be weakened. Splice the spar beyond the point of fastening with the external brace struts, if possible.

Use $\frac{1}{8}$ in., two ply mahogany plywood for the sides of the box spar. Be sure to have spruce blocks about 3 in. wide at all points in the spars where wing fittings and drift struts attach; also where the aileron control pulleys fasten.

According to this system, wire No. 1 is entirely concealed, except where it emerges from the wing a short distance in front of the rear beam, on its way back to the elevator horns. The pulleys shown in the sketch are fastened to the back side of the front beam one above the other, using a simple sheet steel fitting. From the pulley A the simplest method is to bring the wire out of the wing on a direct line to the control stick; this way is open to the objection that it causes considerable head resistance. By the use of two additional pulleys, wire No. 2 may be kept entirely concealed.

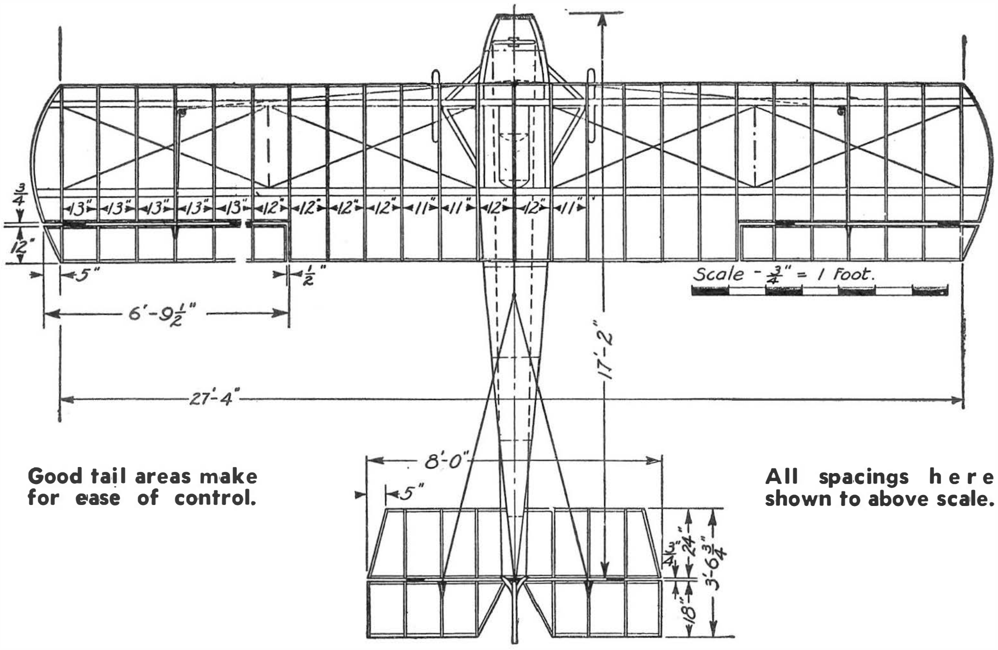
In assembling the wing, the two spars are placed on two horses, and the ribs are slid on to the proper place and nailed there. A carpenter's square is used to get the right angle between the rib and the spar. Next make up the brace wires, and put them in; you will notice that there are two bays on each side of the fuselage; the two drift wires and the anti-drift wire are led as shown above, from their anchorages and are safetied. • • •

PART 2

ALCOR SPORTPLANE FITTING DETAILS

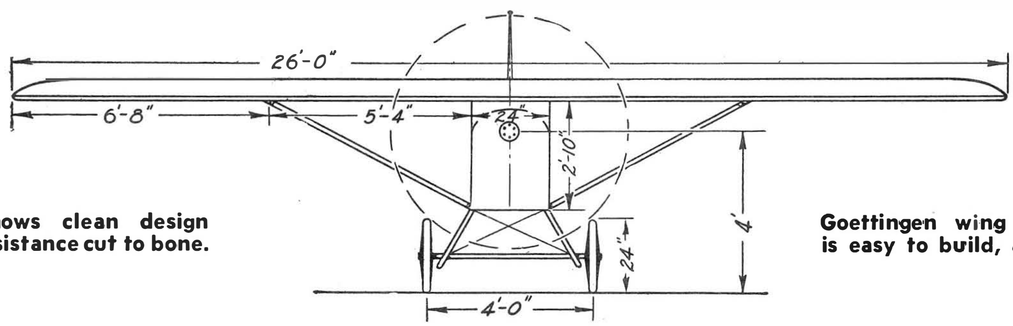
You are now ready to start the real work of assembling the fuselage. There are several ways of going at it, but probably the easiest way is to build the sides up first. Placing the upper longeron on a wide work bench, line it up until it is perfectly straight, then hold it in that position with spikes driven into the bench on each side. Then starting at what will be the stern post of the fuselage, put in your vertical strut, nail on the $\frac{1}{8}$ in. plywood gusset plates. Then go on to the next vertical strut, already cut to length and ready to put in place, insert it and the diagonal, bring the lower longeron into place and hold it there by nailing the lower gusset plates on.

The lower longeron assumes almost a straight line between the two stations mentioned, making it easy to bring it up into place. Carry on in this way until the side of the fuselage is entirely built



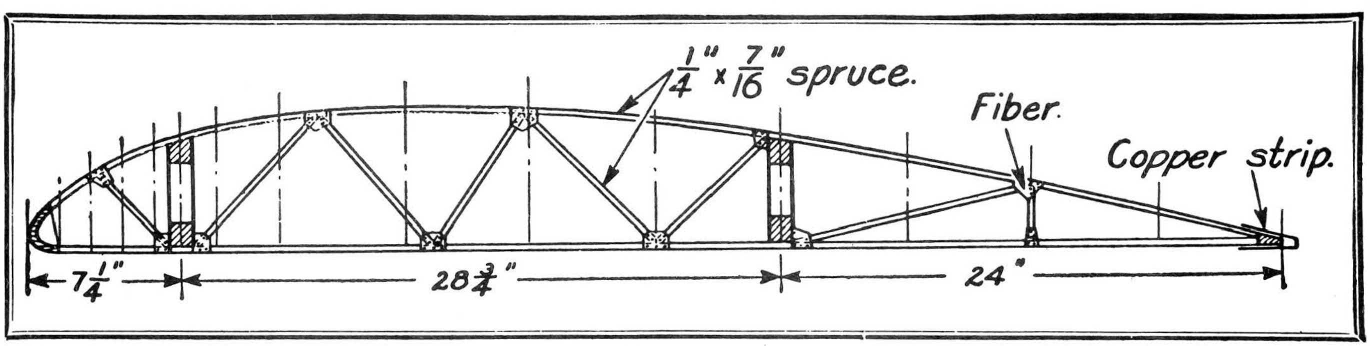
Good tail areas make for ease of control.

All spacings here shown to above scale.

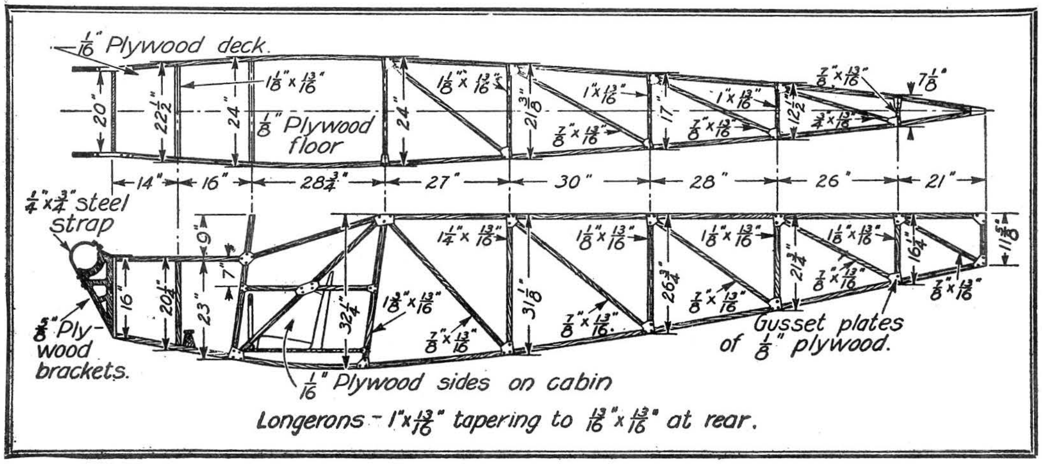


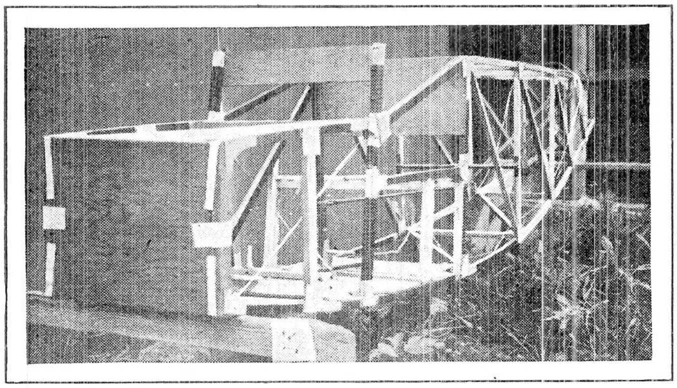
Front view shows clean design with parasite resistance cut to bone.

Goettingen wing firmly braced is easy to build, and very stout.



Ordinates for this Goettingen wing curve (somewhat similar to the Clark Y wing section) will be found in the text. Lay the rib jig out according to this plan.





In this photo are shown the plywood fire wall or bulkhead, the method of taping struts to prevent splitting. Note N framing.

out and rounded piece of spruce as shown on the wing curve drawing, and attaches to the ribs by means of screws about $1\frac{1}{2}$ in. long.

These screws go through the almost vertical front strut between the two cap strips, as shown.

The nose piece or leading edge, as it is called, fills out the front part of the wing curve. It is not attached until after ribs are slid on the spars and fixed in position. After the gusset plates have been nailed on one side, the rib is removed from the jig, and the gusset plates are nailed on the other side. Design your gusset plates so that they are as strong as possible without being large. If fiber is used, tin snips make a convenient tool for cutting the gusset plates to shape. If plywood is used, it will be necessary to use a saw. When both sides of the rib are nailed, the patches may be trimmed with a pocket knife and the end of the rib cut off to the right length. The ribs may now be given a heavy coat of spar varnish and set aside until you are ready for the wing assembly.

In addition to the 12 long ribs required, 12 short ribs are needed; also one special short rib in the center of the wing extending from the rear beam to the trailing edge; the gas tank will rest in the space between the front and rear beams in the wing on the left side of the fuselage, and the wing will be cut out from the front beam or spar forward in order to afford the pilot a better view.

The short ribs are made exactly like the long ones except that shorter cap strips are used and an extra vertical strut is placed at the rear. The false beam for taking the control hinges is attached to these struts by means of nails when the wing is ready for assembly. The sketch below shows method of placing the vertical strut at the proper place.

The aileron ribs are built up separately, using the same jig as before. The width overall of the ailerons is 12 in., and this includes the small beam at the front which is $\frac{1}{2}$ in. spruce and is attached

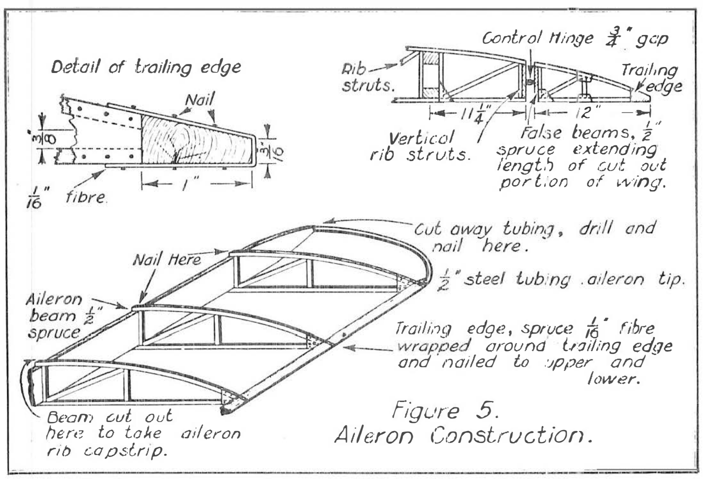


Figure 5.
Aileron Construction.

Figure 4.
Showing method of attaching nose piece after ribs are slid on the wing spars.

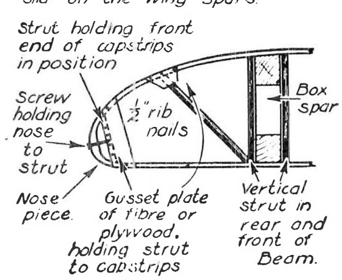
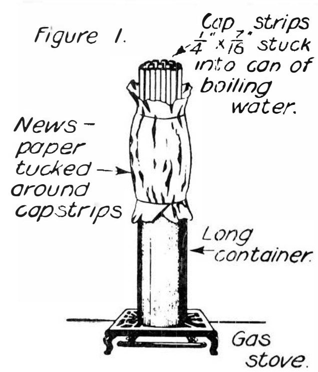
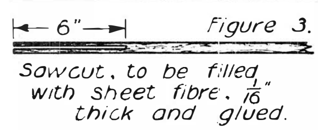


Figure 1.

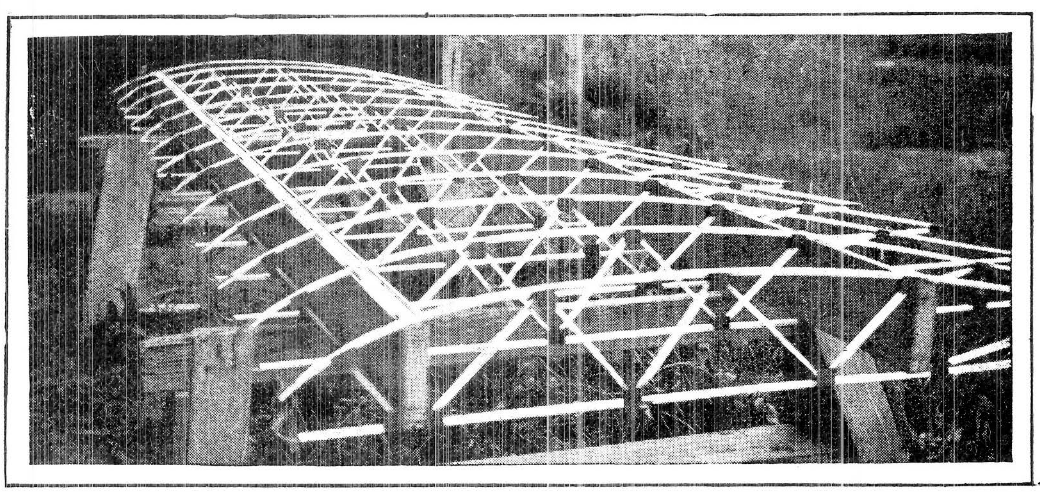


The method for steaming wing ribs so they will bend is shown. Soak ribs in water first.

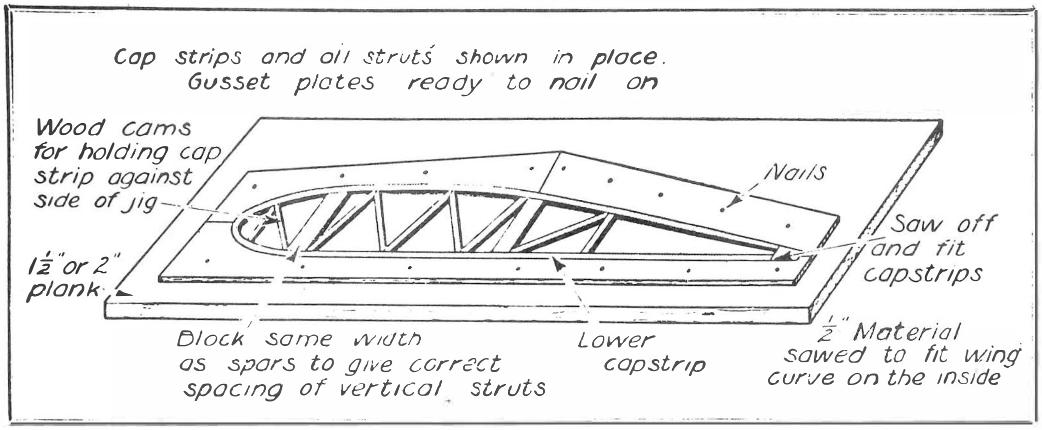
Figure 3.



The ribs are sawn for the fiber and are glued, so that the gusset plates may be fastened at the ends of the wing ribs.



Here is a photo of the completed skeleton wing panel for one side of the ship. The fiber side gusset plates are plainly shown. Note the adequate spar depth and sturdy appearance.



This will give you an idea of the method by which wing ribs are made. The jig is made of wood and saves many an hour in the building up of the trussed wing ribs. One-half inch material is sawed and laid on a plank to serve as template.

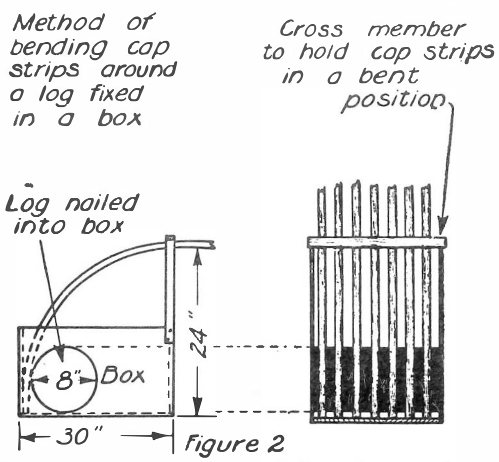
The figures are not needed in building the Alco Sport Plane, since the figures for the half size rib may be doubled to get the full size curve; they are given merely to show the young designer the line of attack in designing and making a rib jig.

Making the rib jig: The sketch of the rib jig shows how the jig for turning out the 24 ribs required, is made.

The jig is mounted on a large plank about 2 in. thick, so that there will be plenty of weight to support the hammer blows when the gusset plates are tacked on the ribs. As shown in the figure, the lower surface of the rib is flat except at the nose, and it will be very easy to saw out the lower half of the jig, using a paper pattern made from the full size wing curve as a guide. Half inch pine is good enough for the purpose.

Since the camber of the upper half of the jig is great, it will probably call for two boards sawed to shape and joined as shown. The half inch material is nailed securely to the planking using inch and a half nails with big heads.

Use the half size rib drawing to determine approximately where the beam centers should lie with respect to the chord, and also where the diagonal struts join the upper and lower cap strips.



In a smoothed log placed in a box such as shown, the cap strips for the wing ribs are placed and bent. The cross member which holds the ribs while the steam dries out may be made of a piece of strap iron, held by screws.

Design your short struts so that two or more are alike. This can easily be done without sacrificing any strength, and by so doing you will save considerable time in getting your struts ready. Blocks of wood ½ in. thick are put in to show where the spars pass through the ribs, and these furnish a guide for the vertical rib struts which fit tightly against the sides of the spars when the wing is assembled. The cap strips and all brace struts for the ribs are made from spruce, ¼ in. by 7/16 in., and long enough to give a few inches extra over the length required by the rib jig, say 5 ft. 3 in. There is danger of breaking the cap strips, especially the upper, when putting them in the jig, unless special precautions are taken.

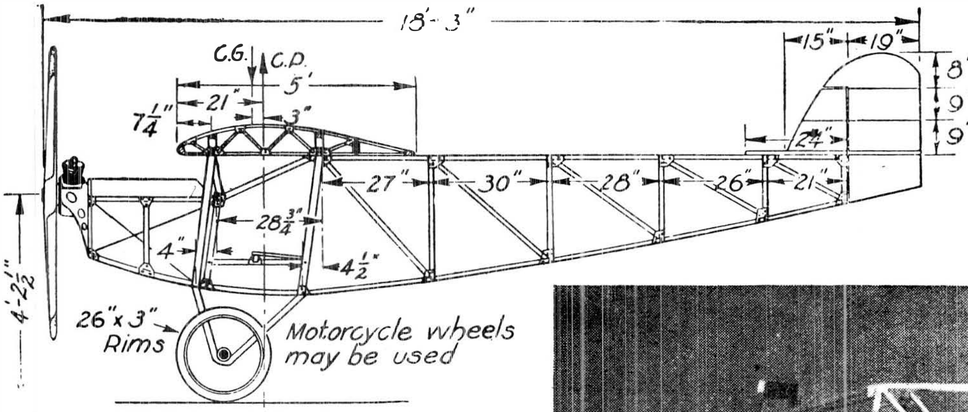
The best method is to steam the cap strips in a long container, holding at least 6 in. of water for about two hours. A newspaper is wrapped around the top of the container to hold in the steam.

At the end of this time, the cap strips will be in a pliable condition and can be bent easily without danger of breaking. The next thing is to put the cap strips in some sort of device for holding them in position until they cool and take on a permanent set. The figure shows such a device.

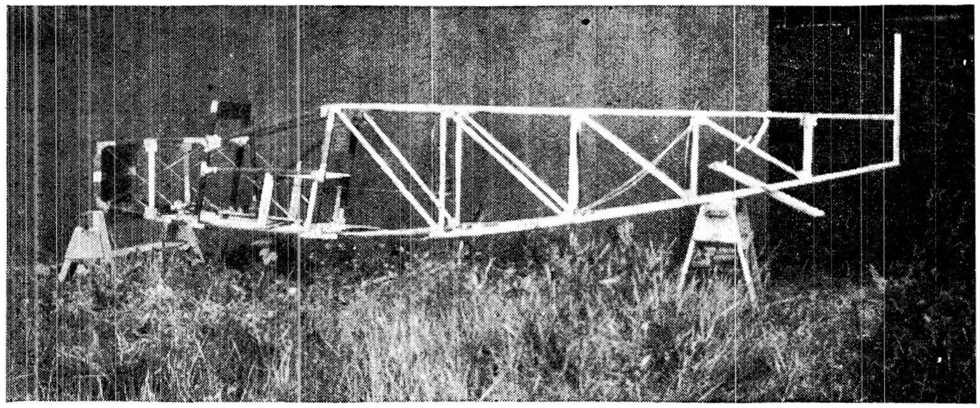
Another way of fixing the cap strips so that they will bend easily is to saw a slot about 6 or 8 in. long in the end of the cap strip where the bend is the sharpest.

Cut a strip of 1/16 in. fiber to fit the slot; apply plenty of glue to the fiber before inserting in the slot. Before the glue starts to set, place the cap strip in the jig, (the upper one first, then the lower one). Next put all vertical and diagonal struts in the proper places, and start nailing on the pieces of fiber or plywood which act as gusset plates to hold the different members firmly together. ½ in. by 20 gauge, is the proper sized nail to use for this work.

As shown on the drawing of the rib jig, small cams are used to hold the cap strip firmly against the sides of the jig. Without these, the cap strips would tend to sag away. These cams pivot around a screw in the plank. The cap strips do not go clear forward on the jig, since a little space must be left for fitting the nose; the nose is a hollowed



Chief measurements for the fuselage layout may be gleaned from this layout which shows the profile view of the skeleton ship.



In this view of the fuselage, you will note the use of wood members tied together with the gusset plates, just as members of a bridge are held together. This is a simple strong form of construction, and safe.

ly referred to by those interested in aviation. Since his graduation from college, the writer has been associated with his brother in manufacturing high lift replacement wings for war production ships, and small sportplanes which are sold for the most part in knockdown form; that is, without motor, and covering. The knockdown plane consists of all parts such as ribs, spars, fuselage struts, etc., ready to assemble into the complete sportplane. By buying these parts, instead of the complete plane, ready to fly away, the purchaser saves himself a good percentage of the first cost of his plane. Some customers prefer to build their plane up from the raw material, (spruce, cloth, dope, sheet metal, etc.), using the blueprints as a guide for getting the correct proportions and dimensions.

The writer estimates that he has sold over 3,000 sets of plans in the last few years, and he has yet to hear of anyone who built one of the planes which failed to fly. For the benefit of readers of *Flying Manual,* the writer will start telling in simple language how to construct the Alco Sport Monoplane.

Below are the specifications, (Motorcycle engine):

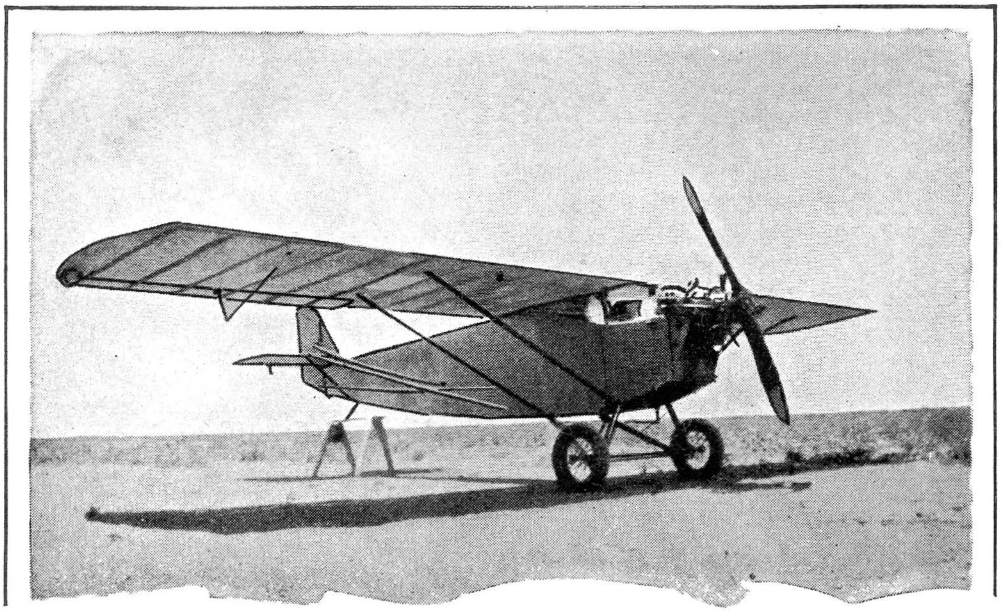
Length overall	18 ft. 3 in.
Weight empty	375 lbs.
High speed	75 mph
Low speed	30 mph
Landing speed	30 mph
Wing span	26 ft.
Wing chord	5 ft.
Gas consumption	1 3/4 gal. per hr.
Cruising range (with 10 gal. tank)	400 miles

The first installment of this article will take up the building of the wing. The Gottingen 365 airfoil is used. This section has proved very successful on several transoceanic flights; the blueprints show a half size drawing. However, if you want to lay out the rib directly without doubling the scale shown in the drawing, the following table of ordinates will be found useful:

%	Upper	Lower
0	1.26	1.26
1 1/4	3.42	.05
2 1/2	4.74	.00
5	6.58	.00
7 1/2	7.89	.00
10	8.95	.00
15	10.22	.00
20	11.00	.00
30	11.58	.00
40	11.58	.00
50	10.79	.00
60	9.47	.00
70	7.47	.00
80	5.26	.00
90	2.89	.00
95	1.58	.00
100	.26	.00

The first column is percent of the wing chord and the chord in this case may be measured along the lower side of the aerofoil since it is perfectly flat except at the nose. The other two columns are plotted against the chord to get the aerofoil drawing for unity chord. For five foot chord plottings all you would have to do would be to multiply the upper and lower aerofoil readings by .60. Five feet is equal to 60 in., and unity chord may be called 100 in. 60/1000 is equal to .60. The above figures are taken from Report No. 124, published by the National Advisory Committee for Aeronautics, and may be obtained free from the Washington, D.C., headquarters by anyone interested in designing.

PART 1



Complete ALCO SPORTPLANE Plans

By John M. Allison, A.E.

For the last nine years, or since 1920, the Allison Airplane Co., at Lawrence, Kans., has been marketing plans and blueprints, and selling knockdown parts for a smali sport monoplane carrying one or two people with less than 65 hp.

Hundreds of amateur builders have made and flown the little ship successfully, using the most ordinary tools for doing the work. These ambitious young men, with typical Yankee ingenuity, have set up their workshop in the parlor, cellar, or barn, and there they have built their rib jigs, made ribs, and the many other items involved before the assembly of the complete plane. Later the complete plane was test flown from some pasture or other small field, by the owner-pilot, who designed the plane.

The Alco is a true "flivver" plane, designed especially for the man who wants to fly a plane of his own without investing several thousand dollars in a commercial plane that he would probably "crack up" and damage before he was scarcely capable of handling a plane with any degree of confidence in the air.

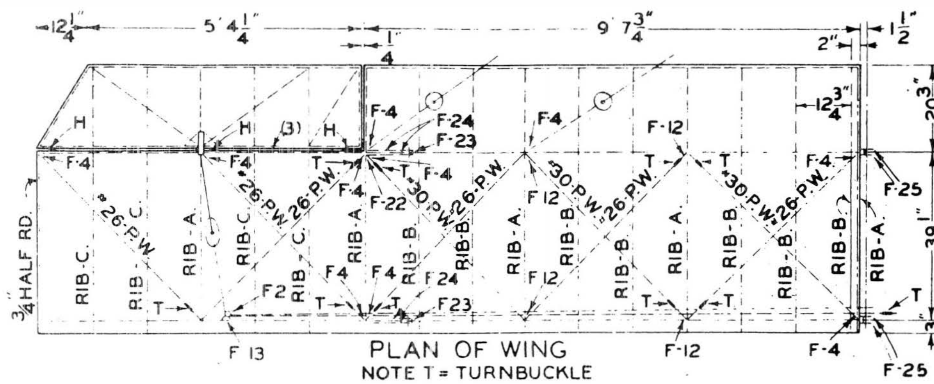
The Alco costs only $100.00 to build, without the motor. He saves himself hundreds of dollars by using his plane to pile up flying time that is required by the United States Department of Commerce before issuing a pilot's license. Some of the more daring men have actually taught themselves to fly by the time-honored method used by the pioneers in this country about 1910; this system consists of first "taxiing" around on the field until they could handle the plane nicely on the ground; then short straight-away flights of a few feet while the plane is just barely off the ground; then making longer flights at a higher altitude, as skill and confidence are required, until finally they found themselves banking, zooming, and performing all the other feats that are commonplace in the lives of experienced aviators.

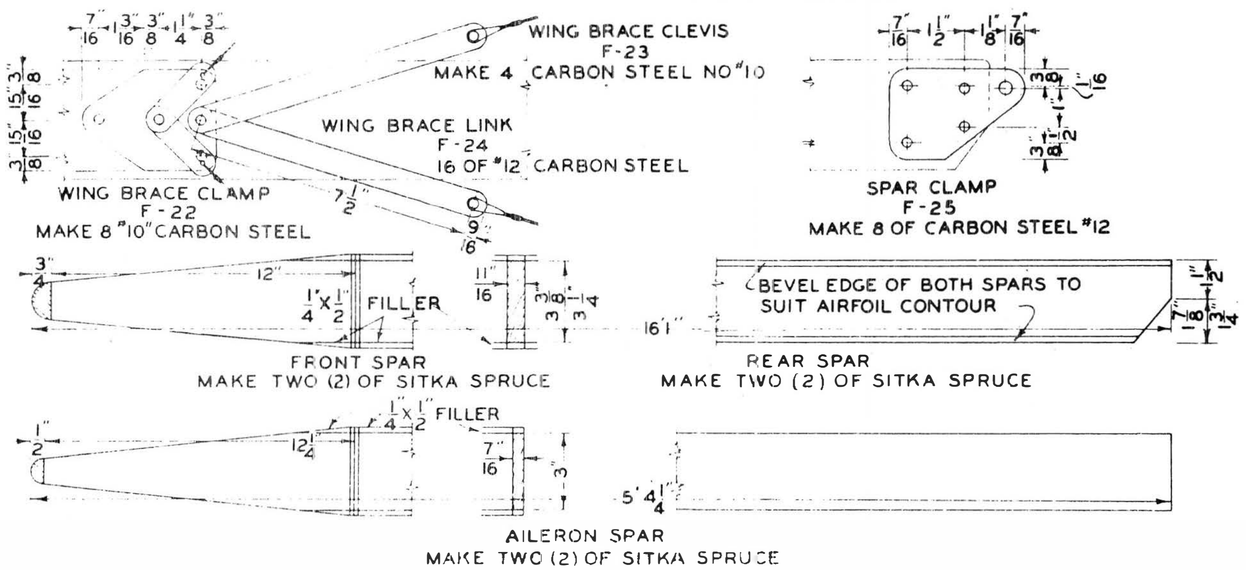
Perhaps after the beginner has built his plane with a motorcycle motor, and successfully flown it, he will feel the urge for more power and range. He will then replace his motorcycle engine which he probably obtained at a junk yard or motorcycle shop for about $15.00, with a slightly more powerful and expensive engine, say the Lawrence two cylinder opposed 28 hp air cooled engine which sells new for about $100.00 at the present time. The new engine makes the plane capable of greater range and better performance.

So it goes, until the young pilot is absolutely at home in the air, and can fly any type of plane without difficulty.

The history, as given above, is in fact the history of the designer of this plane. The writer taught himself to fly in 1922 in a small plane of his own design. While a student in mechanical engineering at the University of Kansas, he wrote several papers on aeronautical subjects, which are frequent-

The wing assembly may be scaled from this drawing, which diagrammatically shows plan of the wing framing and drift wiring. The dimensions for the wing spars, both front and rear, are also shown in full. The wing trussing has been carefully calculated by expert German designers.





a length of rope, will be required to start the glider from an "at rest" position. There is a hook on the front of the glider skid, under which the tow rope is hooked.

This tow rope is preferably a length of ordinary airplane shock cord attached to 30 ft. lengths of ½ in. manila rope. The length of the shock cord should also be about 30 ft. The two men on one side, the hook in the middle, and the two men on the other side serve to form a large "V." The flyer takes his position on the seat of the glider, and two boys hold the wings level. The men run down hill, keeping their paths parallel, and before the rope is at a sufficient angle to drop out, an extra jerk is applied, much the same as an angler makes when striking a fish.

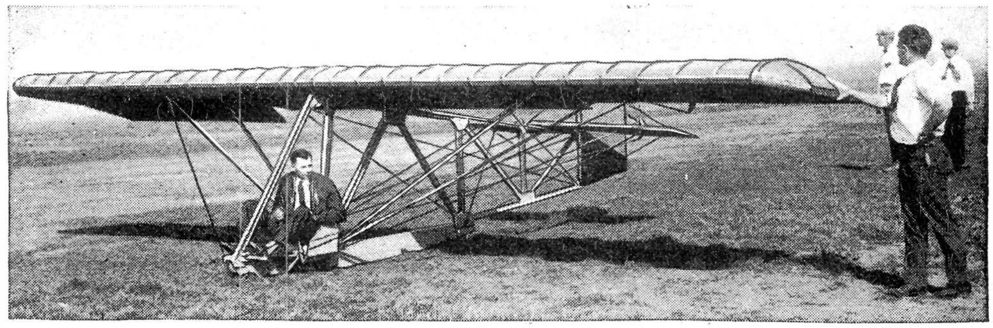
The shock cord will apply this pull gradually. The rope will fall free, and at this point the flyer assumes a gliding angle, for he is then at the peak of his flight as far as altitude is concerned.

A variation of this method of flying is the one in use in Germany. There eight or ten men, using a rope made entirely of shock cord, hook the glider to a rack which is sprung by a trigger under the control of the pilot. The men execute a tug of war with the glider until they are at the limit of the cord's elasticity. They are then lying prone on the ground, their feet anchored to spots specially prepared. The pilot flicks the trigger and the stored up energy of the ten men is released through the contracting of the shock cord and the flyer is aloft in a twinkling. Then, like tobogganing, there is a long walk back.

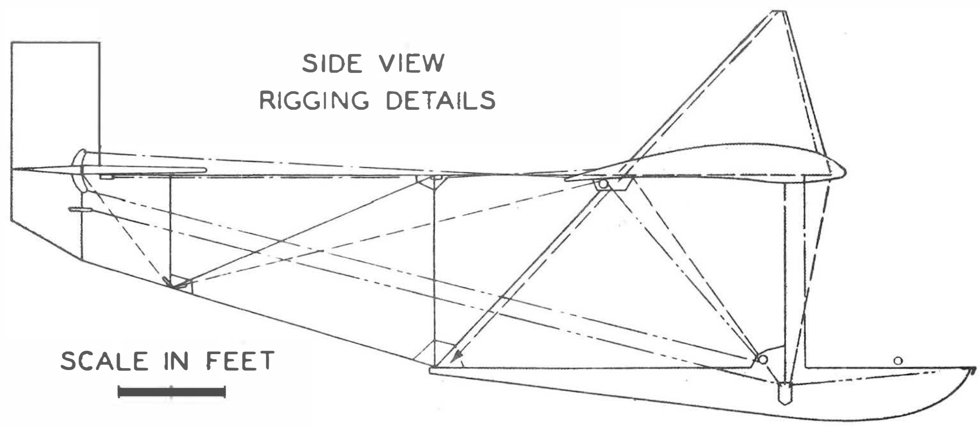
Gliders which are capable of making soaring flights are scheduled for future issues of the magazine. Plans for the Bowlus glider, in which Dale Drake made his epochal flight to Long Beach from Reedley, Calif., will be published. Such soaring gliders are easy and cheap to make, but are somewhat more of a hazard than the flying of an ordinary training glider, the function of which is to accustom the pilot to the control of the airplane.

The soaring glider has an unusual field, and is subject to somewhat different laws of action. It is loaded very lightly, say two to three pounds to the foot of surface, and is built to fly at a low sinking speed in a rising current of air. This light loading, of course, makes this kind of glider subject to the whims of every puff of wind. The theory upon which the German pilots have made their phenomenal flights has been to fly in a country where the winds rose over the hilltops and fell on the other side. Using the up-draft over one hill, the pilot will alter his course when at the peak of the current and use the altitude thus gained to glide to another ascending current.

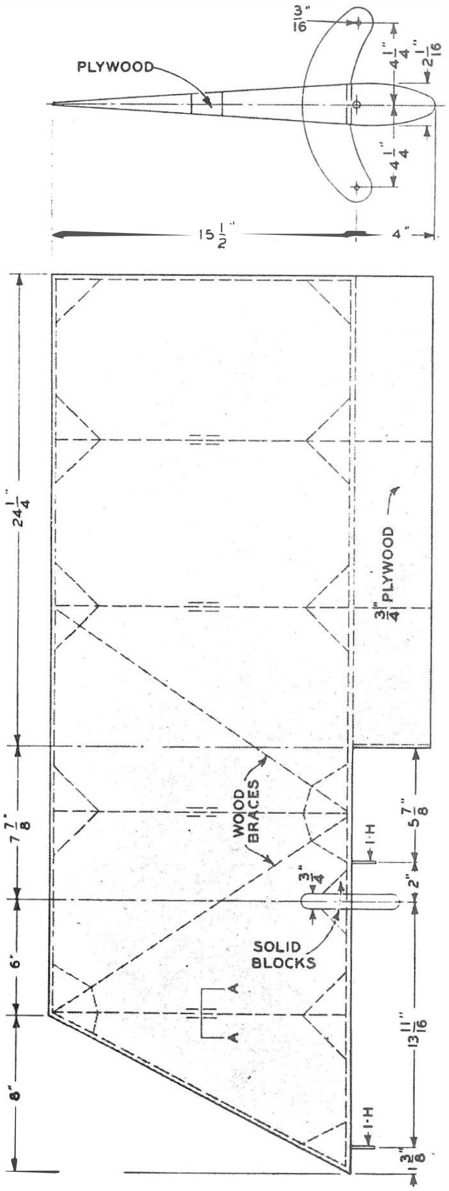
Training gliders are a bit more heavily loaded, though lightly enough for all that. They are more in line with the lightplanes sponsored in America by *Modern Mechanics.* • • •

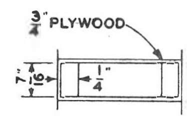


After he had negotiated his epochal towing flight in a glider from Reedley, Calif., to Long Beach, Dale Drake gave an exhibition of gliding in this home-built glider, built from the plans of an earlier version of the Northrop German training glider for which plans appear in this issue.



Here is the control and side elevation rigging plan. The trussing to the pylon or cabane is clearly shown, as well as the leads to the elevators, rudder and ailerons. The solid members of the fuselage have been indicated merely by lines for the sake of clearness. The scale indicates the dimensions.



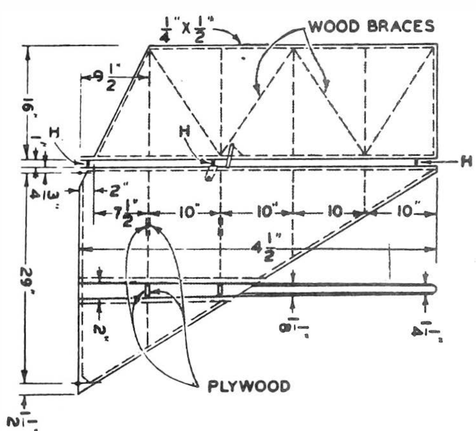


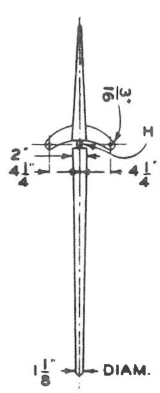
SECTION ON A-A

RUDDER
SCALE IN INCHES

Rudder sections shown in full.

The stabilizer and rudder assembly is very simple. Care should be used to glue the plywood with hot waterproof glue.





ELEVATOR AND STABILIZER

back.

Control cables to be seven strand flexible wire cord looped through fitting with "thimble" insert. Bind loop with copper wire bindings sweated with solder, double back loose end and bind.

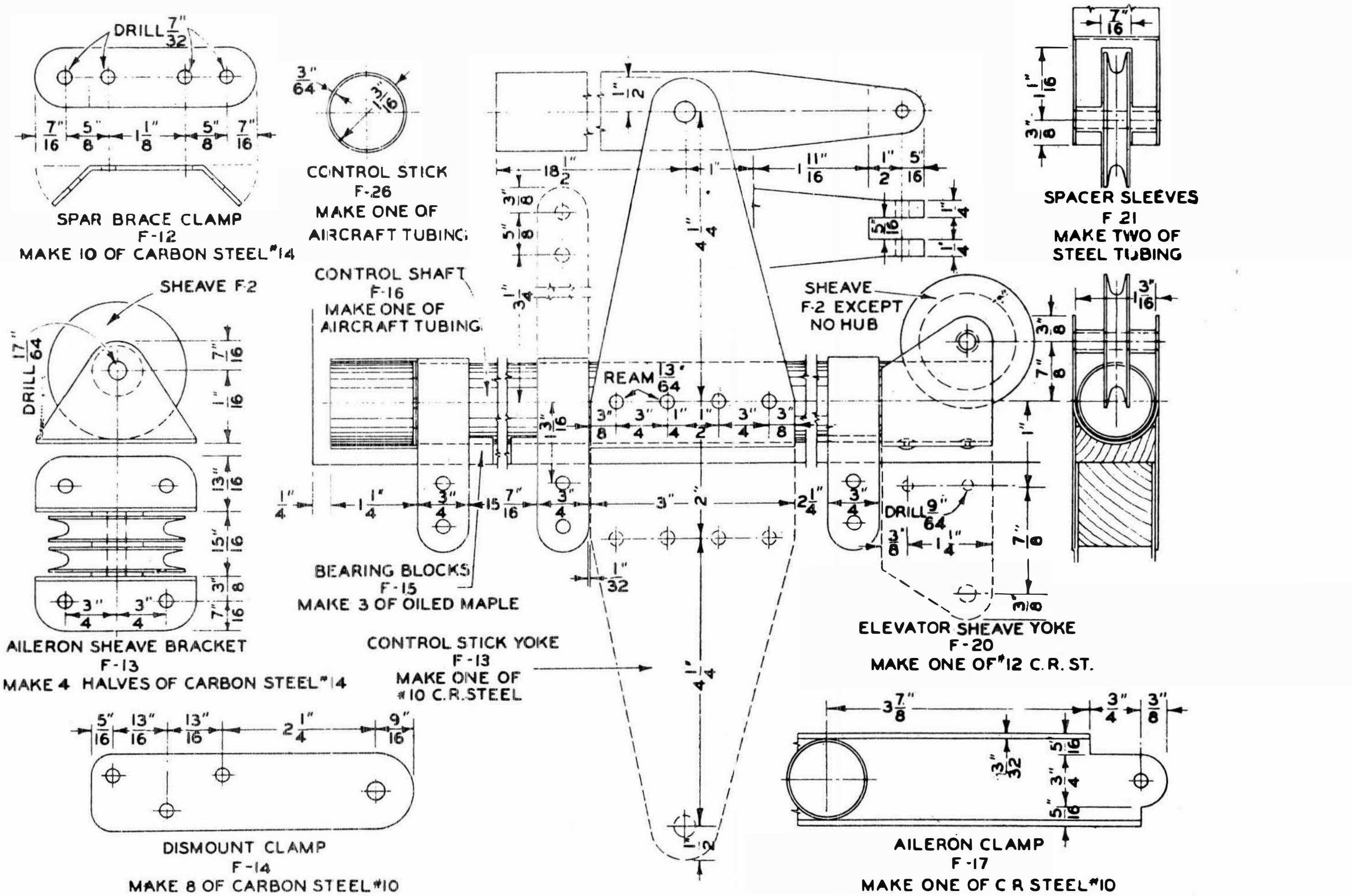
Pins for hinges and doubled links are to be carbon steel of proper length and secured with aircraft safety pin or cotter pins.

Turnbuckles to be standard type of correct size to develop full strength of wire or cable and after tightening, secure from turning with copper wire lacing.

Rigging—Assemble all units properly and securely connected. Tighten guy wires, stays and braces so that wings and stabilizer will be straight, level and at right angles to fuselage. Adjust control wires so that when all controls are in "neutral" the ailerons conform to the wing shape and the elevator center line conforms to the stabilizer center line.

The flying of a glider requires the help of a few men. It is suggested that a Glider Club be organized and turns taken by the members in flying the "ship."

Launching a glider is in itself a fine form of exercise. The glider, if used and flown from a gently rolling hilly country, must be launched at about the same speed at which a man can run. Four good stout men, pulling two and two on the ends of



SPAR BRACE CLAMP
F-12
MAKE 10 OF CARBON STEEL #14

CONTROL STICK
F-26
MAKE ONE OF AIRCRAFT TUBING

SPACER SLEEVES
F 21
MAKE TWO OF STEEL TUBING

CONTROL SHAFT
F-16
MAKE ONE OF AIRCRAFT TUBING

SHEAVE F-2 EXCEPT NO HUB

AILERON SHEAVE BRACKET
F-13
MAKE 4 HALVES OF CARBON STEEL #14

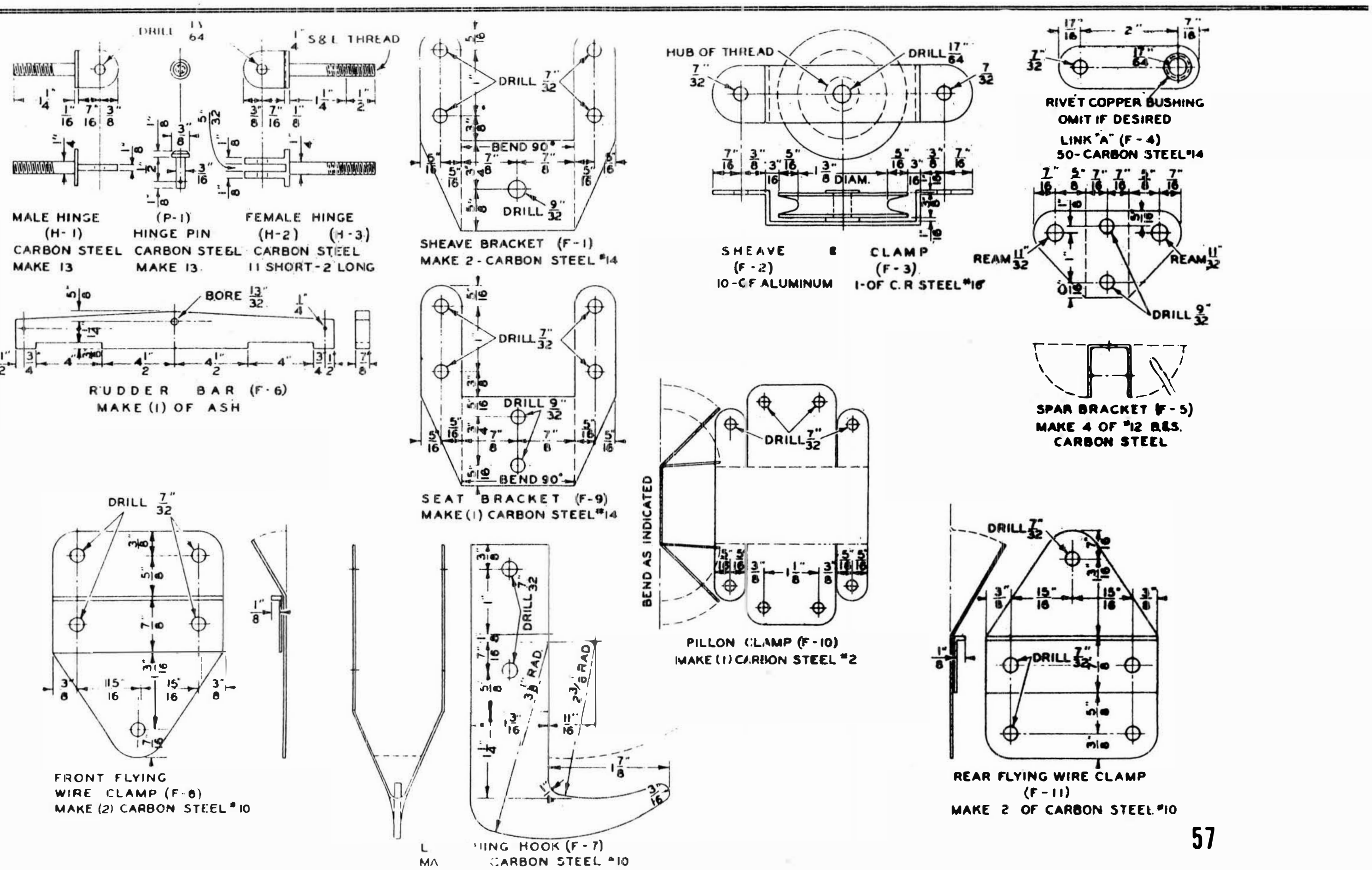
BEARING BLOCKS
F-15
MAKE 3 OF OILED MAPLE

CONTROL STICK YOKE
F-13
MAKE ONE OF #10 C.R.STEEL

ELEVATOR SHEAVE YOKE
F-20
MAKE ONE OF #12 C.R.ST.

DISMOUNT CLAMP
F-14
MAKE 8 OF CARBON STEEL #10

AILERON CLAMP
F-17
MAKE ONE OF C R STEEL #10



MALE HINGE (H-1) CARBON STEEL MAKE 13

(P-1) HINGE PIN CARBON STEEL MAKE 13

FEMALE HINGE (H-2) (H-3) CARBON STEEL 11 SHORT - 2 LONG

SHEAVE BRACKET (F-1)
MAKE 2 - CARBON STEEL #14

SHEAVE (F-2) 10-OF ALUMINUM

CLAMP (F-3) 1-OF C.R STEEL #16

RIVET COPPER BUSHING OMIT IF DESIRED
LINK "A" (F-4)
50-CARBON STEEL #14

RUDDER BAR (F-6)
MAKE (1) OF ASH

SEAT BRACKET (F-9)
MAKE (1) CARBON STEEL #14

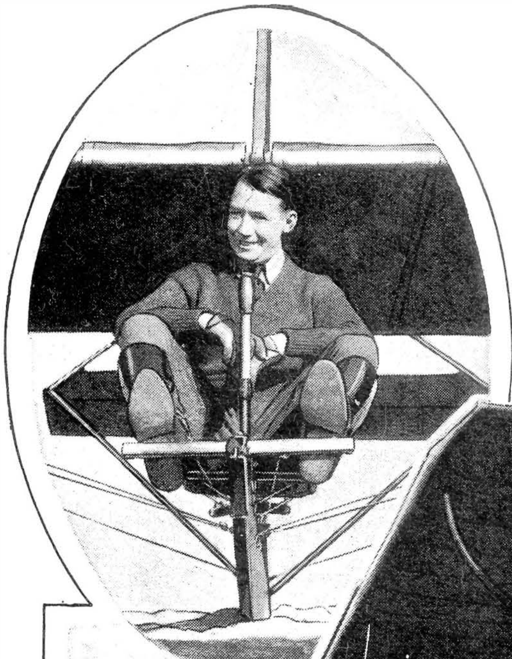
SPAR BRACKET (F-5)
MAKE 4 OF #12 B&S. CARBON STEEL

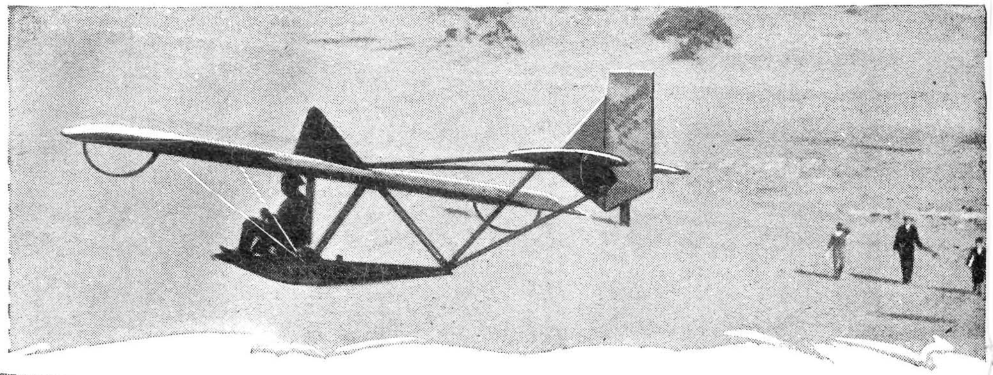
PILLON CLAMP (F-10)
MAKE (1) CARBON STEEL #2

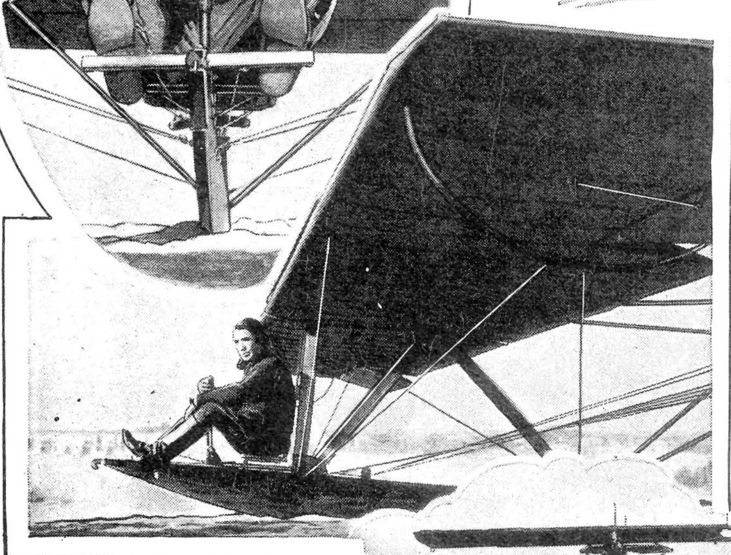
FRONT FLYING WIRE CLAMP (F-8)
MAKE (2) CARBON STEEL #10

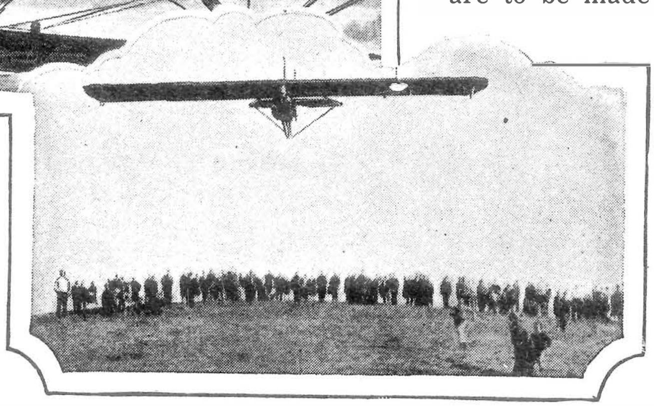
L... ...ING HOOK (F-7)
MA... ...CARBON STEEL #10

REAR FLYING WIRE CLAMP
(F-11)
MAKE 2 OF CARBON STEEL #10









Here is Mr. Charles Ferguson, President of the California Gliders' Club, about to take off in a glider of the Northrop imported German type.

The control system of the Northrop imported German training glider is absurdly simple. The complete dimensioned drawing is given to the right. The carbon steel fittings must be annealed before working.

The drawing right shows details of small fittings on Northrop Glider.

strips to wood plate to give outline "in negative" of all members. Cut accurately and lay all members of first half into jig, glue all joints and glue on "gusset" plates of plywood. When glue is set remove and glue onto the other members when properly fitted into jig of reverse pattern.

Wing Assembly—Lay out spars and drill for all fitting bolts. Slide ribs into positions, bolt fittings into place, align and glue ribs to spars, shimming where necessary to get solid bearing. Insert "trailing edge" strip and glue in place. Cut and assemble bracing wires. Tighten wires and align the wing, true to 1/8 in. Install aileron control cables and pulleys.

Ailerons—Make ribs in same manner as wings. Assemble complete, and attach to wing spar with hinges and cover with fabric.

Covering—Cover all surfaces except nose, with "A" grade mercerized cotton drawn tight and cemented at all edges to framework and to ribs on rear half of lower surface with aircraft dope. Cover nose with plywood bent to shape, glued in place and "bradded" with cigar box nails to "filler strip" on top and bottom of spar between ribs, bending forward edge of "fabric." Puncture at proper point for guy wires and control cables and reinforce with patches.

Ash for runner shoe and clamps shall be of sound, straight grain, quarter sawed kiln dried stock.

Dope—apply with at least two hours between coats, two good coats of an approved aircraft dope.

Tail Surfaces (Rudder, stabilizer and elevator) are to be made as shown of similar material, in similar manner, aligned, covered and doped same as wings.

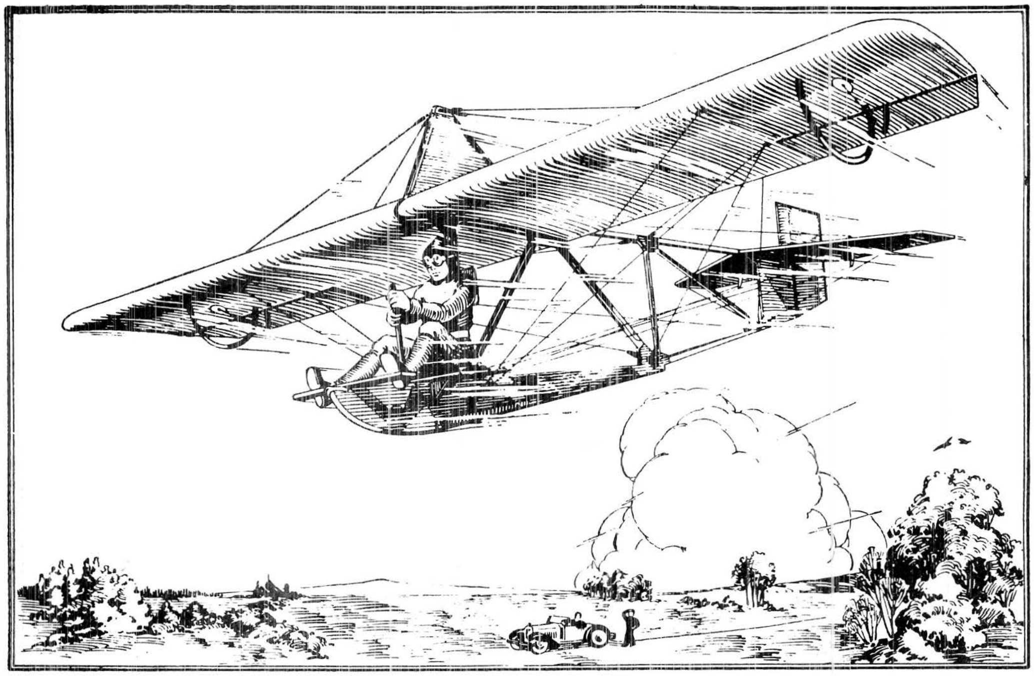
Fuselage—Make all members as shown, lay out according to dimensions, fit all joints accurately and glued together with necessary blocking and stiffeners. Cover runner, tail fin surface and pylon also "gusset" plates at joints with plywood as noted and glue together. Apply and bolt on all fittings.

Glue to be best grade government specification casein waterproof glue applied hot.

Fittings are to be made accurately as shown and of materials noted. Carbon steel to be annealed before bending and tempered afterward.

Bolts to be carbon or high tension steel, threaded SAE or USF 32 thread for 3/16 in. bolts. After tightening nut into place, cut bolt flush with nut and "rivet" (to prevent loosening) with four center punch indentations in thread circle.

Wire to be "piano wire" looped through fitting "safety" secured and with loose end doubled



In country where there are no suitable hills with correspondingly good gliding terrain, such as the Kansas prairies, the glider may be towed from behind a car using shock cord as a tow rope.

mounted, and because of the popularity of the Duede glider which ran in the March issue of *Modern Mechanics,* we present this latest word in gliders, which can be built for about $30.00, to our readers.

The Northrop ship will take off at about 15-20 mph. Its high speed is not much higher, and is dependent of course upon the altitude which is gained and the rate of glide.

On page 53 the profile plan is shown. You will notice that this drawing is keyed with references such as F-11, F-4, etc. These are references to figures given in detail in some other drawing. Thus the whole set of plans is cross-checked, and the builder will have absolutely no difficulty in building the ship if he uses his head. This method serves two purposes. For instance, on the profile drawing, F-11 is evidently a fitting too small to show in detail on that drawing. On another drawing, namely the fitting blueprint, we find F-11 to be the rear flying wire clamp, fully dimensioned so anyone can build it.

Again, we see pulley F-3, and wondering where it is installed, and how, we see the profile drawing again, and discover F-3's true function is to alter the path of travel of the elevator cable. The whole set of plans is beautifully cross-checked, and no questions should present themselves, especially since the following set of specifications treats every item which is not a part of any good mechanic's shop knowledge, and does it in detail both as to the what and how, as well as the why. This article supplements the complete set of prints herewith.

Specifications and Instructions

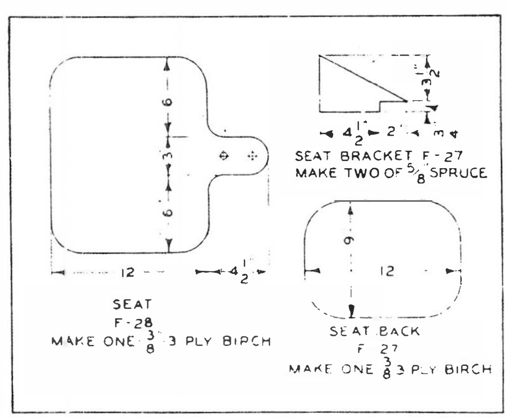
In general: The work should be done inside on a level floor upon which jigs for the assembling of the fuselage and the wing ribs can be laid out as described similarly in Stewart Rouse's articles on the "Heath Parasol" which appeared in the January, February and March issues of *Modern Mechanics.* Materials and parts to be executed as follows, and in accordance with complete drawings accompanying:

Spruce throughout shall be government specification Sitka Spruce, straight grain, sized to correct dimensions. Lower member of runner shall be steam bent, care being taken not to "burn" the wood in steaming.

Struts are to be "stream line" shaped between end plates as indicated by small sections on sheet 1. Rib stock is to be specially selected for straight grain and sized accurately to dimensions.

Plywood throughout is to be Birch "Haskelite" or equal. Short bends for nose of rudder and wings may be made by dampening plywood before application. Bend parallel to surface grain.

Airfoil Jig is mounted on a true flat wood surface. Make outline true to 1/32 in. to the measurements given for airfoil. Fasten 1/4 in. by 3/16 in.



Made of three-ply Haskelite, the seat is cut to the dimensions shown, and mounted on the skid of the plane. The back fastens to the upright T, as diagrammed on page 53.

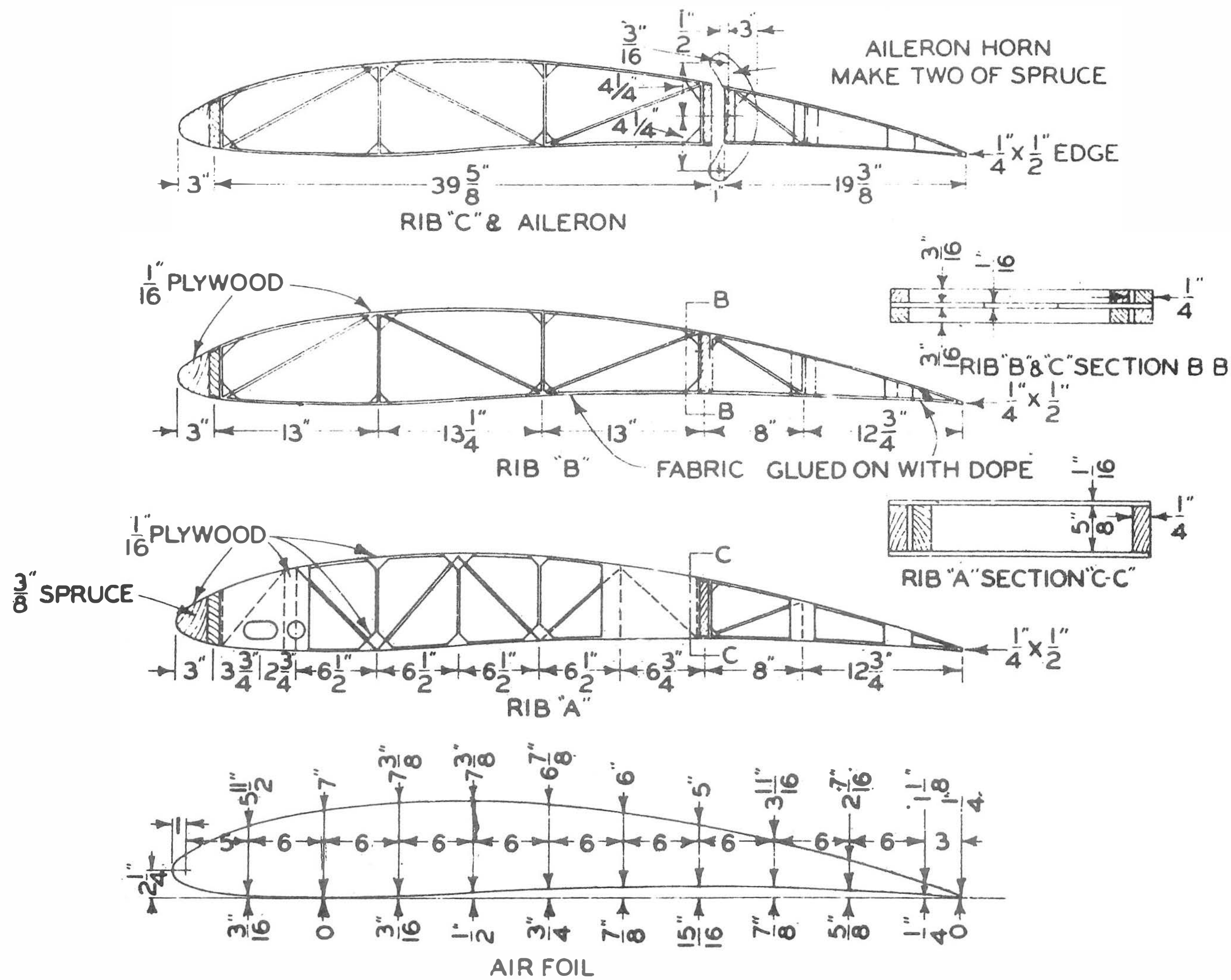
become international. In the United States, designs for the latest and safest types of German training type gliders have been imported, and several glider clubs have been formed. The members work cooperatively, furnishing motive power and the leg work for the man in the machine in turn for the same kind of help when it comes their turn to take the stick.

Almost every university has organized its gliding club, when plans have been available, and the knowledge of aviation gained through the use of these light, safe flying machines, on which no registered casualty is known since Lilienthal's time way back in the 90s, makes it easy for a student to become air-minded, to grasp the feel of the air, which is necessary before he becomes at home at the stick of a powered job.

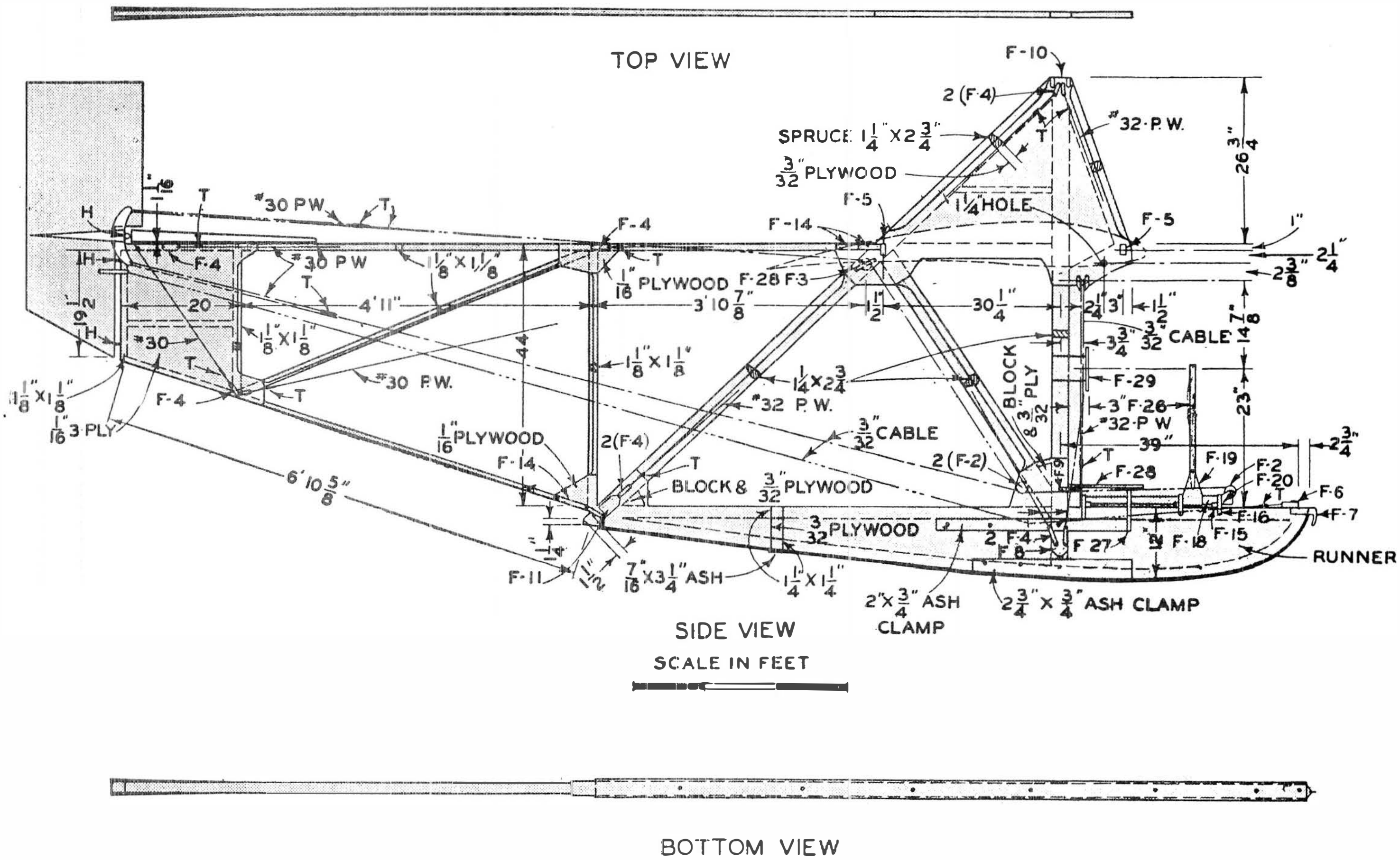
Because of this interest, the editors of *Modern Mechanics,* ever on the lookout for the new, and mindful of their pledge to lead the field in all branches of mechanical sport, have procured the plans of a glider which has just been imported from Germany, in the Rhone mountains, and the plans for this ship have been taken from the actual machine. They are presented in as complete form as is possible in this issue of the magazine.

Here's the story behind the plans you have before you. Up in Minnesota, the home of Lindbergh, Shank, Speed Holman, W. B. Stout, and other names famous in aviation, the word "air-mindedness" is a byword. In the city of Minneapolis, an old time war flyer, Marvin Northrop, owns the largest airplane jobbing supply house west of Ohio. Every year he makes a pilgrimage abroad and thus keeps abreast of the latest foreign developments in flying. Recently returned, Mr. Northrop imported with him one of the German training type gliders — the latest word in stout, safe German training ships.

Having been exhibited at various state fairs and air shows, the glider was flown this spring from behind an automobile which was used as motive power for launching. Proved that such a method would work, it was obvious that no matter what the country, the glider could be flown by some means in any part of the United States. Interest



The wing section is similar to the U. S. 27, modified. This gives higher lift at lower speeds than most sections, and the method of trussing up a rib is shown here clearly. Leading edge is plywood.



Building Instructions and Plans for the NORTHROP GLIDER

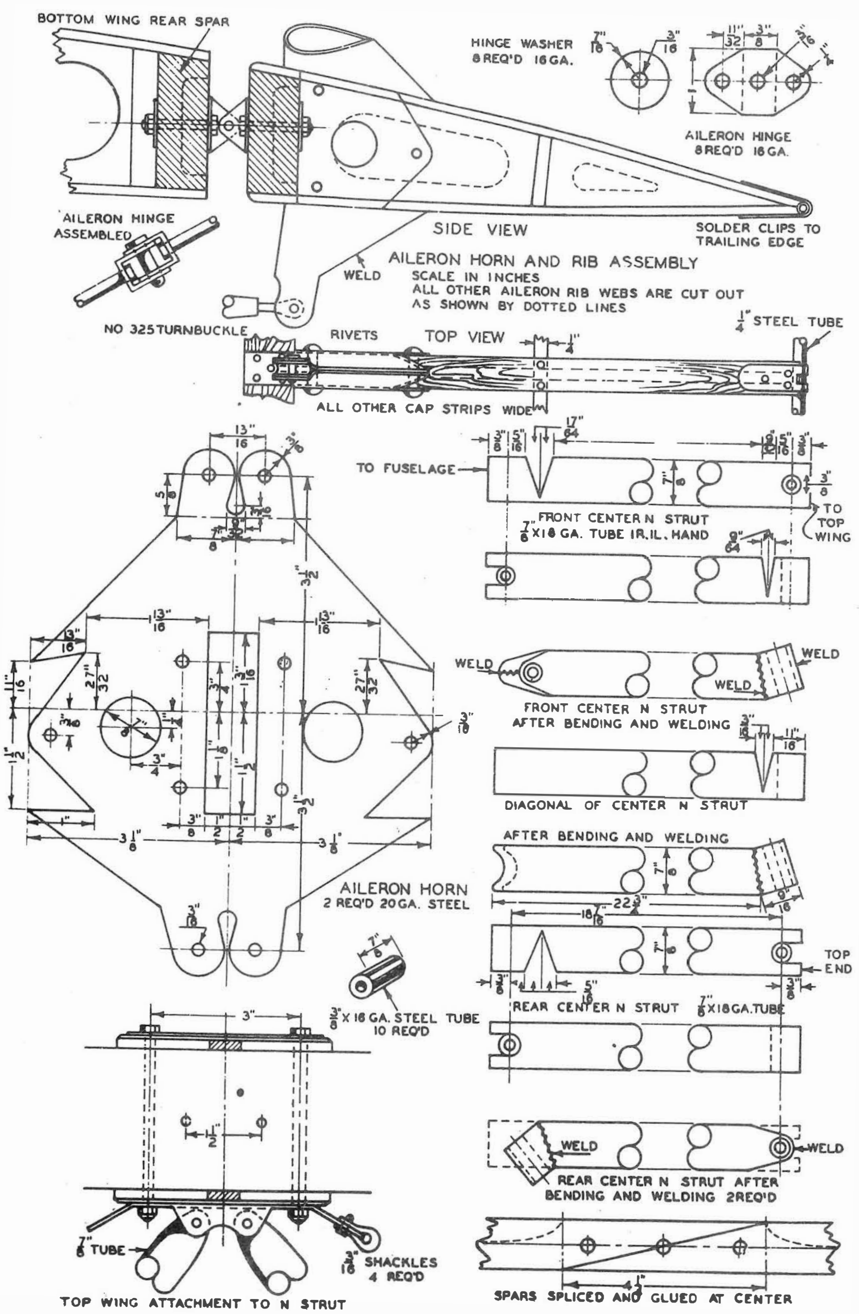
by Weston Farmer

Repressed by restrictions on all sides, Germany's republican peace time activities have turned, at least in aviation matters, toward flight with planes of light power. To gather the needed information with which to build efficient airfoils, and to determine properly the load lifting properties of high span wings, Germany has developed some remarkable machines in the gliders which have been built for experimental purposes.

In fact, so valuable has the glider proved as a simple and safe laboratory for the inculcation of air-mindedness, that the post-war republic has inaugurated gliding schools where gliding is taught to the exclusion of all other branches of aviation.

True, gliding has its limitations. For the exercise of the sport in its truest sense of the word, where soaring flights are made over a span of hours, certain types of country must be provided. The terrain has a lot to do with the success of such flights, and only in the gently rounded slopes of the Rhone mountains have soaring flights been conducted with high success. Ordinary gliding, however — the sport of being launched from a high place such as a hill or a cliff in a sailplane, and expending the altitude thus afforded in a soaring gliding descent — can be practiced anywhere the field for landing is available. Soaring is different from gliding because the direct use of rising currents caused by hilly country is used to kite the glider aloft after it has flown out of one current to another.

Today, because of the remarkable powerless flights which have been made, some of them lasting for 14 hours and better, interest in gliding has



then bent, and drilled the last thing so that the holes will be in line.

The method of making the center section N-strut, or cabane is shown. The welding had best be done by a man used to the work or much tubing will be wasted before a satisfactory job results. The welding of tubing is in itself an art, and all welders are not tubing welders by a long way. The application of the oxy-acetylene welding flame to light tubing such as this is very apt to thin the metal on each side of the weld and nine times out of ten if failure occurs it is at this point and for the above reason. In all points the skill of a welder will be found well worth while.

The accompanying blueprint also shows the Lincoln method of building the trailing edge of their wings, as will be seen from the cross section of the aileron. Quarter-inch by 22 gauge steel tubing is used for this, and is secured to the wing ribs by copper strips. The copper is soldered to the tubing, nailed to the rib, and the nail heads soldered to prevent their coming loose.

The aileron hinges are simple and are readily made out from the drawings. The method of fastening them together is shown. The clevis pin, a standard 3/16 item is used and anchored with a cotter pin.

It is recommended that the builder of this plane, should he wish to fly it, take time from some accredited instructor. It will be the cheapest in the long run and will enable the student to keep his plane intact until he has acquired enough air sense to instinctively do the right thing when an emergency arises.

Modern Mechanics does not advocate the student teaching himself to fly. If, however, he wishes to try it and risk a faulty move which may endanger his ship, here is the way to go about it.

On the take-off, after the motor is warmed so that giving her the gun will not load her up and kill it, the ship is lined directly into the wind. Choose the early morning or the evening before the sun goes down. The air is then heavy, lifts well, and is not bumpy as a general rule.

The throttle is gunned wide out. The stick is shoved way forward so as to lift the tail off the ground. When the nose of the ship is on a line with the horizon the stick is eased back as the ship gains enough speed to keep the nose there, and finally a slight nudge back will lift the ship off the ground, and you are in flight.

Care must be taken not to climb too fast and stall the ship. As a stall approaches the aileron controls become soft. Nose the ship down to regain control.

When about 400 ft. of altitude have been gained head the ship back into the wind for a landing and cut the motor, when flying straight along in normal flight, the air field under you forms a line of vision which approximates the gliding angle of the ship. Cut the gun, nose the ship over into this line, and gently dive for the field. About 10 ft. or so off the ground level off and wait for the ship to begin to settle. Just at the moment you feel the ship begin to settle keep pulling the stick back, settling the tail, until the ship lands on all three points — tail skid and two wheels. • • •

feature in the Lincoln Sportplane if one wants to use the Lawrence.

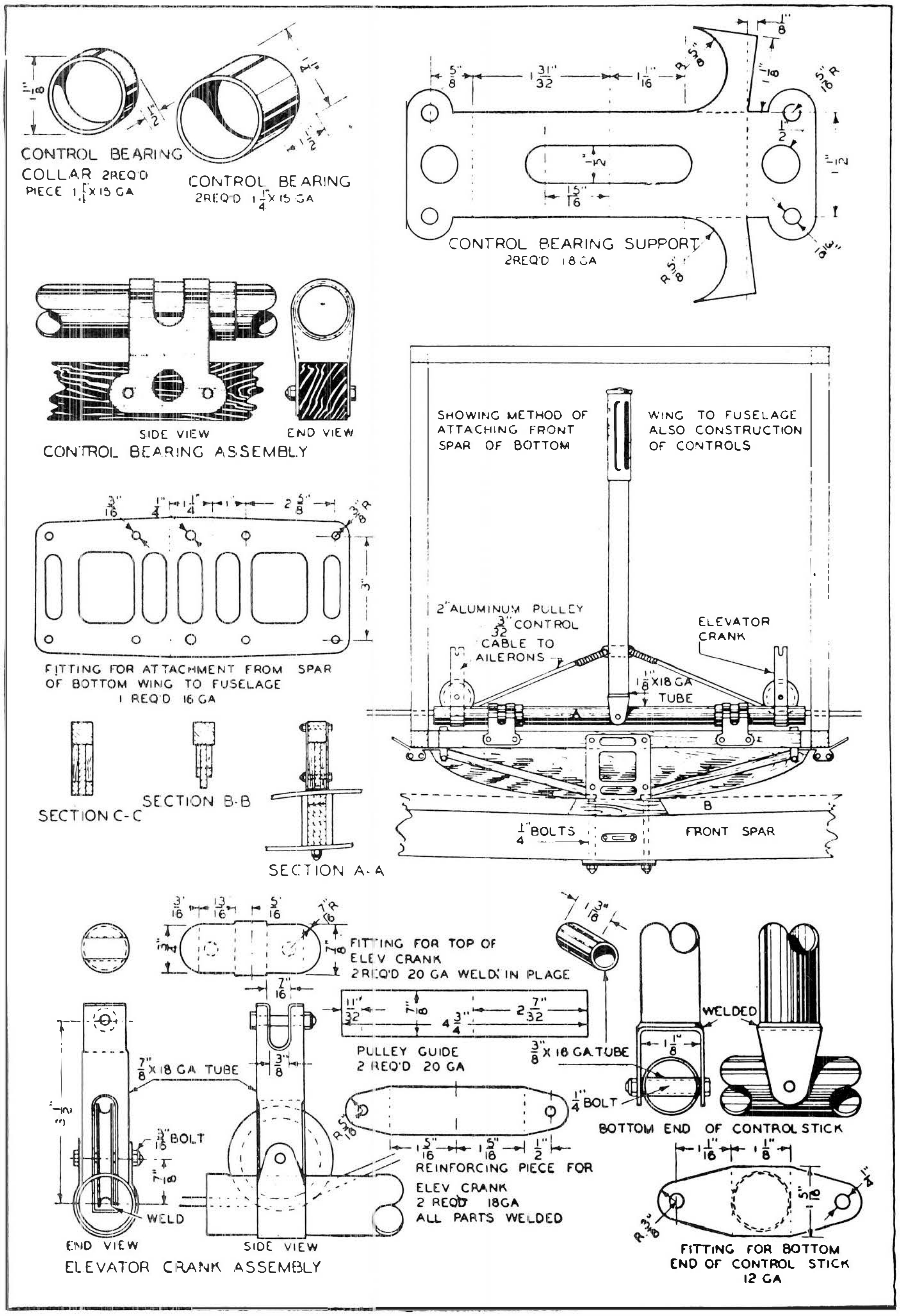
The wing may be covered with Grade A cotton cloth. The loading per square foot is not 51½ lbs. per square foot as was at first printed, but only 5½ lbs. For such a loading, well doped cotton cloth is ample as to strength and lasting qualities. The wing is covered in the usual way by making the covering a tight fitting sack, putting it onto the wing like a stocking, and then sewing it to the ribs. The sewing stitch is merely a tightly made loop about every four inches along the wing ribs.

Start the stitch on one side of the rib, poke the needle through to the under side of the wing, and then bring the thread up through the top again on the other side of the wing.

The blueprint on an accompanying page shows several details worth mentioning at length. Among these is the splice in the wing spars.

As previously mentioned, the dihedral in this design is built in the wing. The spars are spliced at the centers where the cabane strut is mounted and are glued with Curtis cold water glue. The method of joining the spars is shown in the drawing at the lower portion of the page. In the view which may be identified by the dimension 4½ in. showing the length of the splice, it will be noticed that there are ostensibly three holes for bolts. The outer ones are used for the fittings; the center one is a dowel pin.

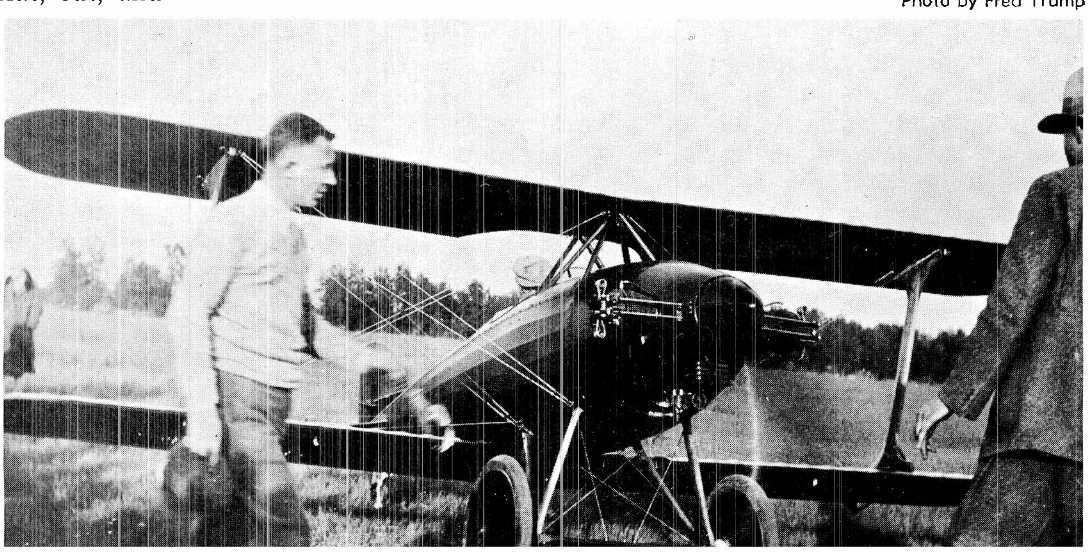
The aileron control horn is a complicated piece of cutting and should be laid out flat, cut, and

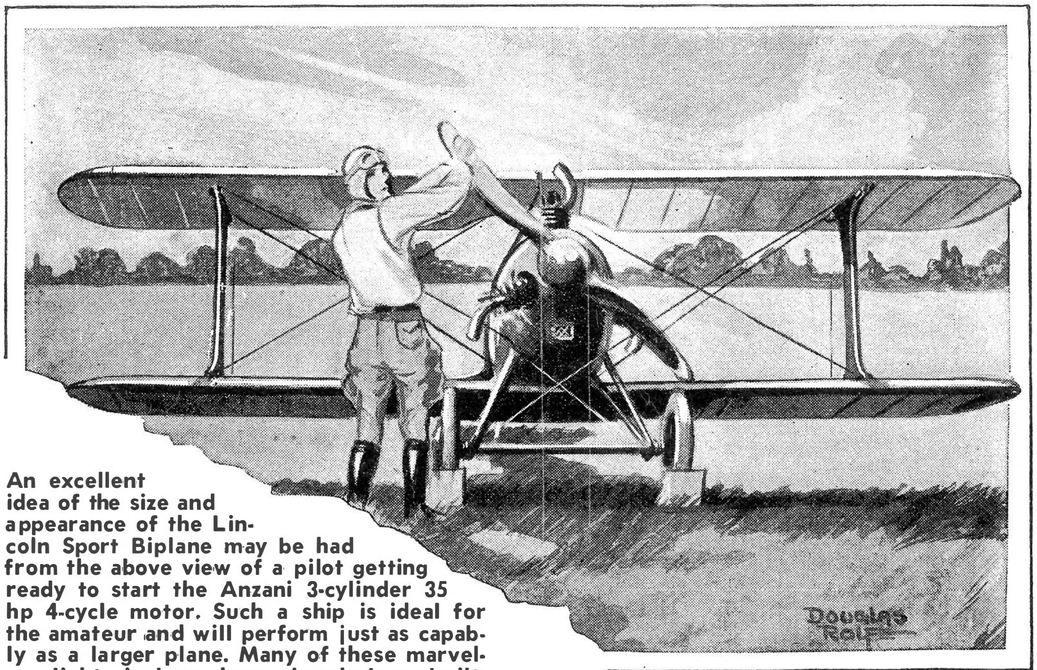


If these directions are followed closely, construction and assembly of the control stick will be an easy task and one that the builder will get a great deal of enjoyment out of performing for himself.

Photo by Fred Trump

Fred Trump's Lawrence powered Lincoln Sport warming up.





An excellent idea of the size and appearance of the Lincoln Sport Biplane may be had from the above view of a pilot getting ready to start the Anzani 3-cylinder 35 hp 4-cycle motor. Such a ship is ideal for the amateur and will perform just as capably as a larger plane. Many of these marvelous light airplanes have already been built.

FUSELAGE SCALE DETAILS OF LINCOLN BIPLANE

Details for the immensely popular little biplane are concluded here. This will put the reader in possession of a complete set of detailed plans for one of the best planes of the day.

PART III

As we glide into the last details for the building of the Lincoln Sportplane let us take a summary of the plans which we have laid before us and from which the ship is to be built.

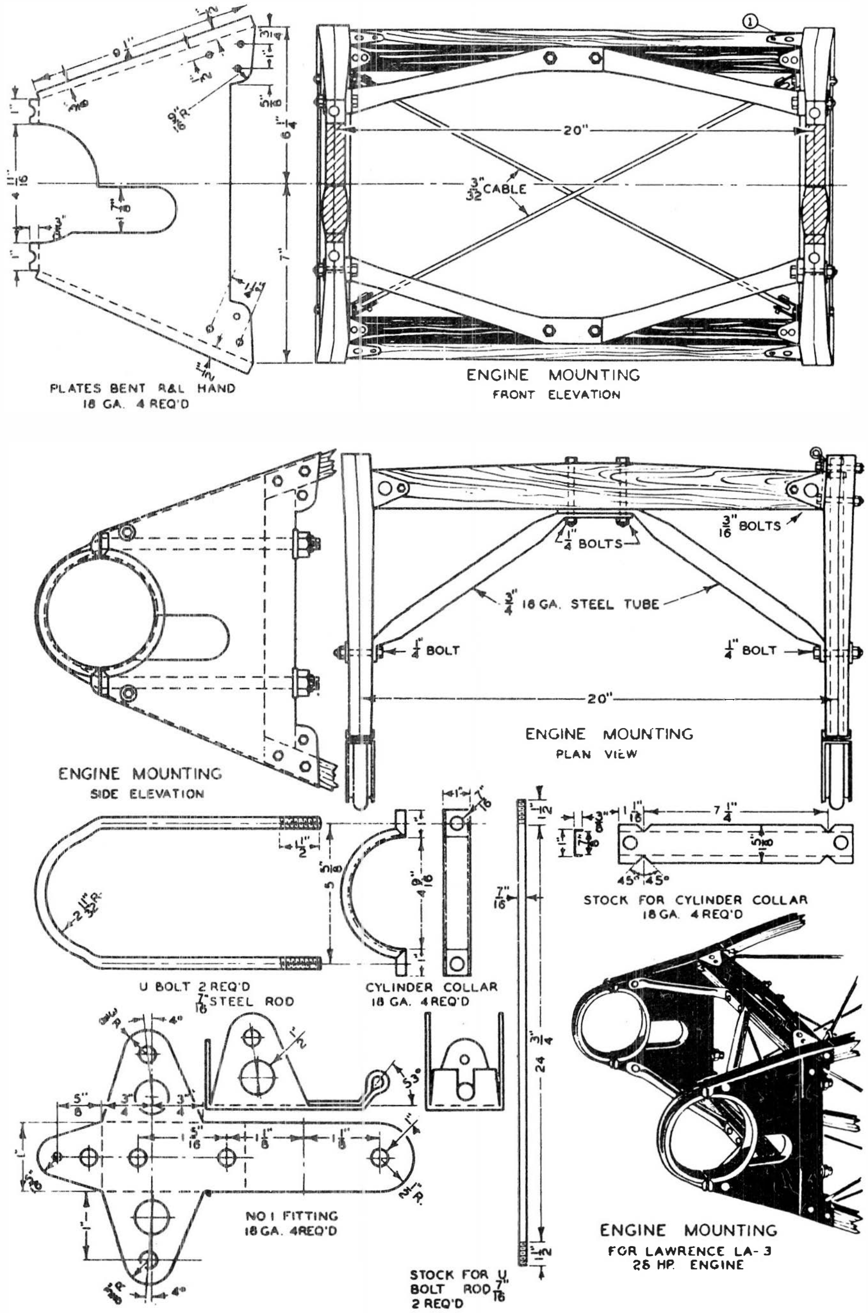
The last part contained the first of the plans, and carried all the dope about the performance and the main layout. The fuselage fittings, the plan view of the fuselage and the wings, the U.S.A. 27 wing section (which, by the way, is obtainable upon application from the National Advisory Committee for Aviation, Navy Building, Washington, D.C.) and the interplane strut and landing carriage details were shown with explanations in that issue. The following part took up the engine mounting, wing mounting, fuselage, strut fittings, stabilizer parts and wing fittings. This issue completes the set of drawings. Anyone at all familiar with the building of an airplane will be able to construct the Lincoln Biplane from the set of details provided through these pages of *Modern Mechanics Flying Manual.*

Should the reader wish, he may secure a set of blueprints for the construction of this ship from the designers, the Lincoln Standard Airplane Co. of Lincoln, Nebr. The price of these prints is five dollars, and though no more complete than the set of plans which the magazine has presented, they are shown to somewhat larger scale and possibly might be a bit easier to work from.

The Lawrence mounting is peculiar in that there are no points of attachment about the engine such as bolts, etc. The mounts for the old Penguin planes in which the Lawrence engines were used were merely U-bolts attached to the lower ends of the cylinder barrels. Use is made of this

The size of the Lincoln Sport Biplane is vividly shown in comparison with the height of a five and a half foot man.

Drawing left gives engine mounting for opposed type engines.



may as well be 1 by 2 in. This will allow you to get clamps in between so as to hold the longerons when they are bent to shape which may take a bit of hot, dry steaming to momentarily soften the wood. The longerons are left in the mold until they are such shape as to be readily bent to form when being rigged.

At this stage of the game it is well to be on guard for the parting of the grain of the wood. Do not allow such splits to occur. The reason is obvious.

The small slight split is the fracture of tomorrow, and if difficulty is encountered in bending the longerons they should be wrapped in cloth. They can then be bent without splitting.

A secondary word might also be here interjected concerning the gluing of the spars and the longerons. Glue if properly handled makes the best joint possible and the splice, like a good weld, is almost always stronger than the original weld. Spruce is used in the wing spars of the Lincoln Sportplane, routed as previously explained, and the dihedral is built in where the wings are spliced.

It would be impossible to get straight spruce of the span of the wing nor would there by any point in it. Therefore as the spar must have dihedral for stability, the dihedral is built in at the splice at this point. The splice is prepared by sawing the spars, which are solid at this point, at complementary angles, planing smooth, gluing, and pressing in a clamp on a form previously laid out to conform to the 176 deg. required as called for in the front elevation.

This clamp need be nothing more than a guide made by nailing two 2 by 4s at the required angles along the floor. You will use them for but four gluings and they may then be taken up.

This method will assure you of having good glue jobs on the wings. The same care must be taken on the gluing of the longerons as to the facing and joining, and no worry will ever result from these points when you are in the air and are called upon to make the ship whine to get yourself out of a tight fix. • • •

Fred Trump's Lincoln Sport just before its first flight. "Speed" Holman pilot, Lawrence engine.

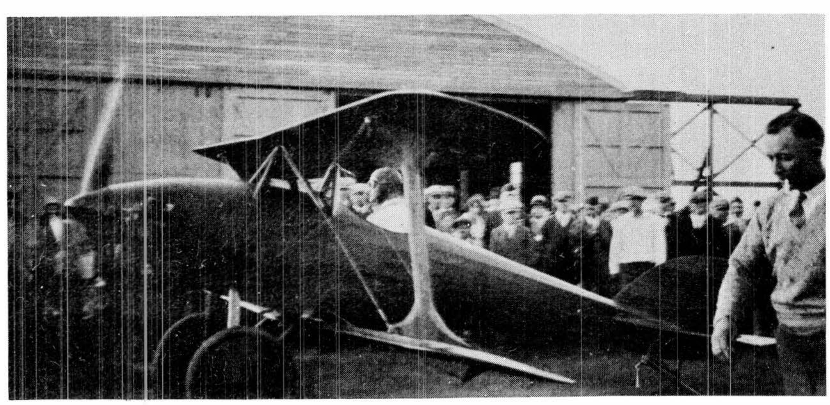


Photo by Fred Trump

Ave., Minneapolis, Minn., and the Johnson Airplane and Supply Co., as well as the Heath Airplane Co., of 1727 Sedgwick St., Chicago, Ill., all sell parts of the type required for the construction of this plane.

It is well to remember in the handling of the sheet metal that goes to make up the fittings of the Lincoln Sportplane no heating must be employed. The metal is cold rolled sheet steel, which is fairly hard, though mild. If it is heated it will lose much of its strength and the result is to invite disaster.

Wooden parts on an airplane such as this are few and can be made in comparatively few hours. It is the metal fittings in which the work to be done is concentrated that takes the care and time. For that reason the attention of the Gang is called to each of these little items as it appears.

Look at the last blueprint in the present article. You will find there the details of the fittings which make up the wing strut anchorages and flying wire attachments, which we have already noted in the remarks and pointers about rigging. You will notice the wing spars are hollowed out on one side, being 1 in. thick at the flange and half inch thick through the channel.

The elevator and aileron pulleys are shown in sufficient detail to enable their construction to be grasped nicely and without any complexity.

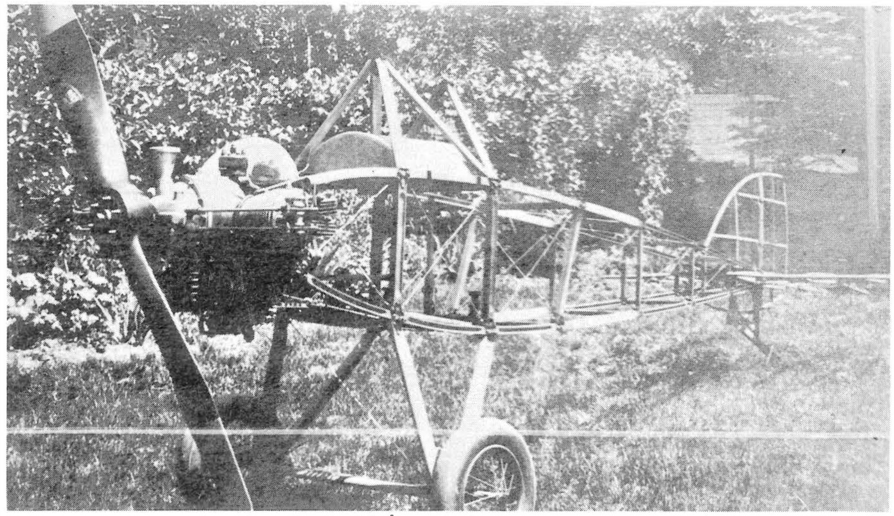
It might here be remarked that in anticipating the particular problems which the builder of the plane might encounter, that the mold previously mentioned for the building of the fuselage calls for a word.

As the fuselage is the same on the top as the bottom the mold can be made thus: the sides are formed out of 2 by 12 planks with the outline of the fuselage marked on them. The outline, or sweep from the nose plate to the tail post is sawed out, and on both planks. Then cross braces are put in.

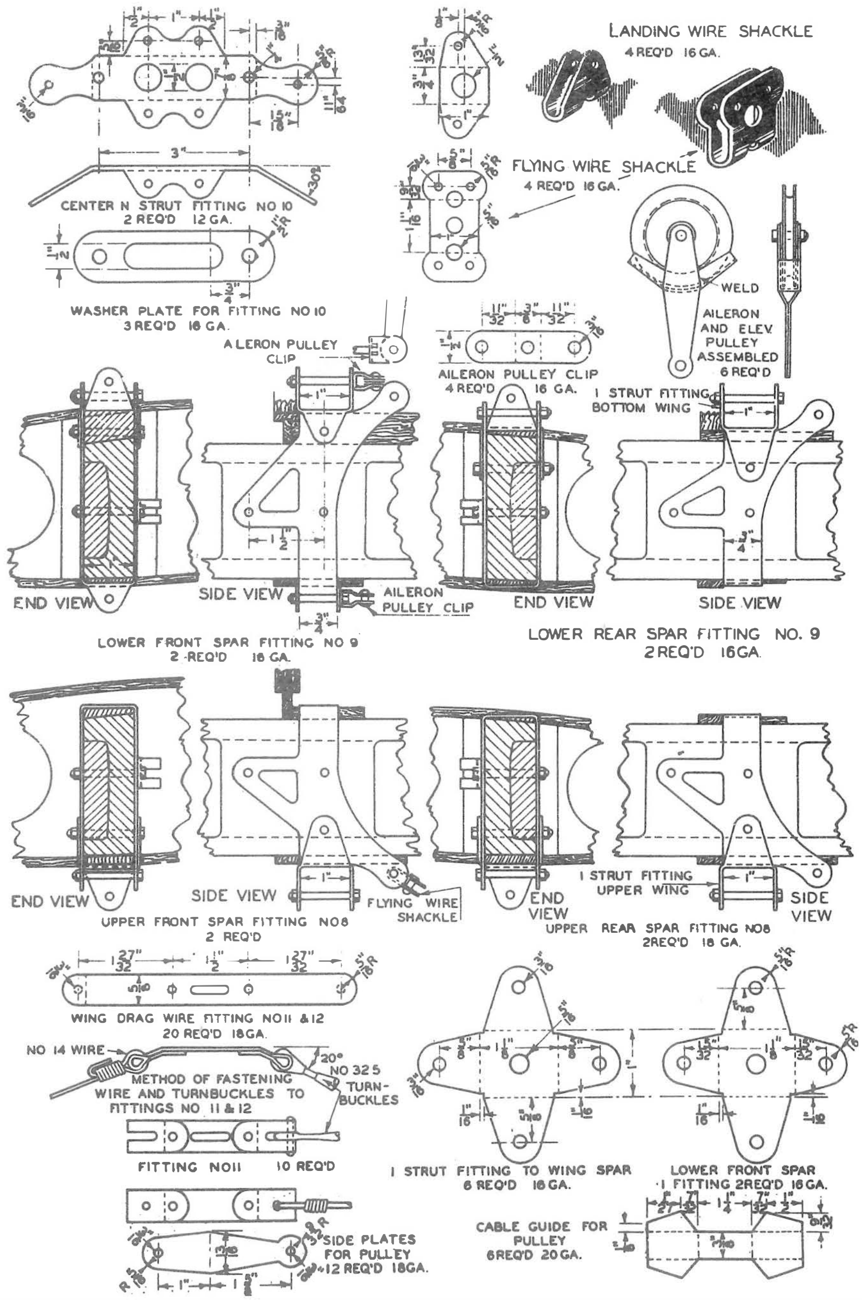
Spacing of Cross Braces

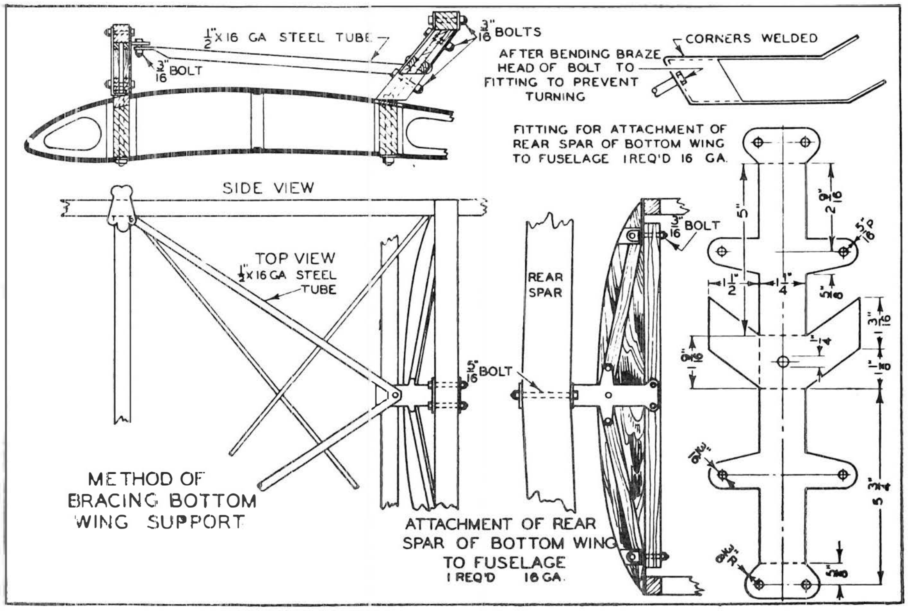
These cross braces should be spaced about 4 in. apart, and

Photo by Fred Trump



Construction details of Fred Trump's Lawrence powered Lincoln Sport.





The manner in which the lower wing is attached to the fuselage is plainly shown in this plan. The fittings rest on the spars, and there are two points of contact on the front spar and one on the rear spar. Half-inch steel tube is used for strutting.

cylinders, and a sort of U-bolt clamp around the cylinders for holding the motor thereto.

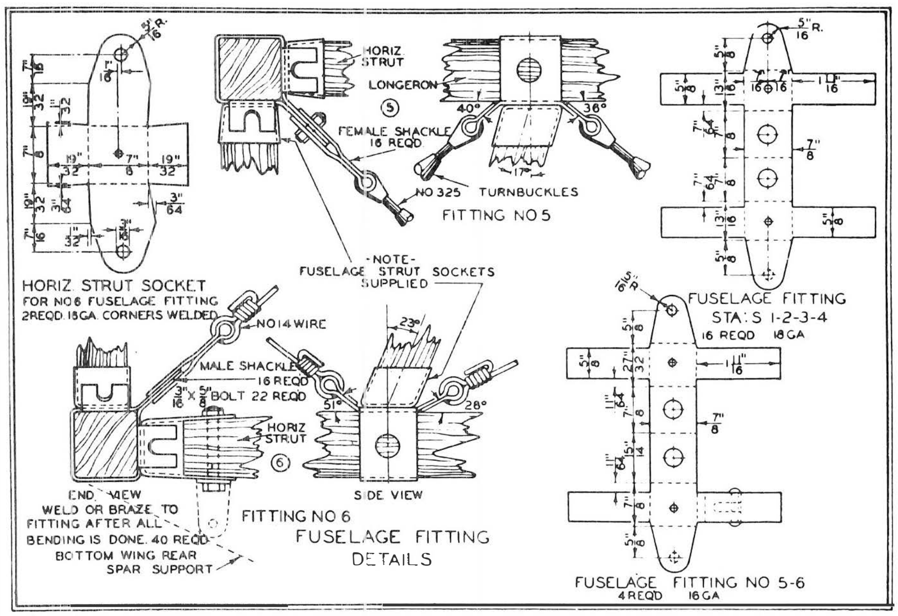
You will notice that the under wing of this particular design is solid too. The dihedral is built in in the usual way.

The wing is mounted in the same way as the famous Bristol Fighters had their lower wings mounted. The lower wing was blanketed but very little, and on maneuvering, side slipping and so on the ships are still the favorites of many a wartime flyer. The mounting of the Lincoln sportplane lower wing is parallel to that of the Bristol and gives a wing which has little interference. The front edge is cut away in small boxes where the landing gear struts are in the way, but the effect is so small that the advantages more than outweigh the disadvantages.

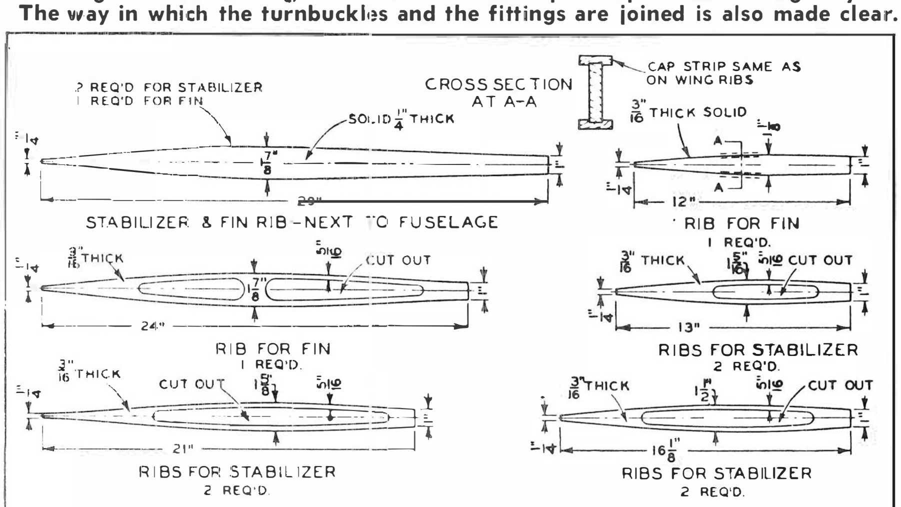
In rigging the wings the landing wires are first snugged home just enough to keep the wings lined up with the blocking you employ to set the wing panels right. If you set them home too snug the splices in the spars will be apt to weaken. When the landing wires have been tightened just enough to take the load off the blocking, the flying wires can be set against them and the rigging is all done.

The strut fitting details shown on page 48 show clearly all of the essential major dimensions of the fittings which are used to anchor the struts to the longerons, and how the turnbuckles are anchored. The turnbuckles indicated may be purchased from the Heath Airplane Co., The Lincoln Standard Aircraft Co., Lincoln, Nebr., or from your nearest supply house.

Mentioning supply houses calls to mind that Nicholas Beazely Airplane Co., Marshall, Mo., Marvin Northrup, 700 Washington



The sizes of the struts, namely 7/8 by 7/8 in. aft of the cockpit, are shown in this drawing. The actual length of the strut will depend upon the fuselage layout. The way in which the turnbuckles and the fittings are joined is also made clear.

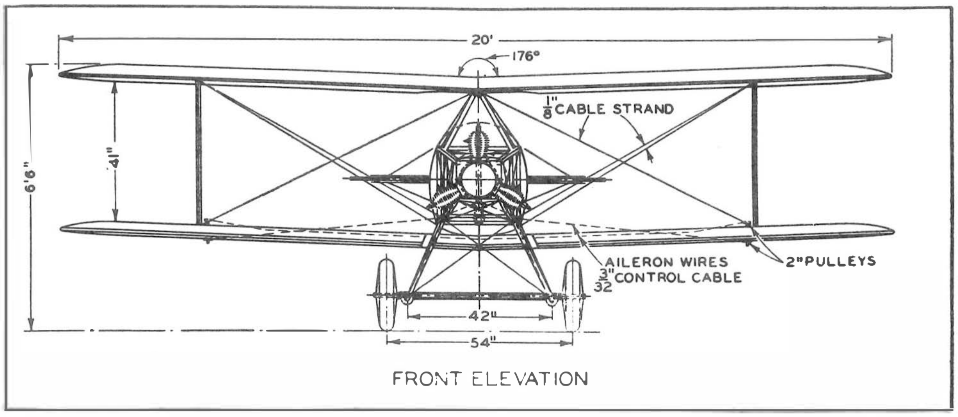


The beautiful little Lincoln Sport Biplane built by Fred Trump to the plans presented herewith. The photo shows the neat cowling job over the Trump converted Lawrence 2-cylinder opposed motor.

forth with a few constructional notes which should be sufficient to clarify how-to-build points for all save rank beginners. The details given in this part will make the set of plans in your possession still more augmented, and in the next part the final details, making the plans complete from start to finish, will be published.

The side elevation calls for attention first. You can get a good idea of the 15¼ in. stagger, which gives the plane very good visibility. The longerons are 7/8 in. ash forward, and are spliced to spruce at the forward cockpit where the notation "No. 14 Wire" is seen. This follows practice which can be seen in any of the wartime production ships, such as Jennies and Standards which may be near your local airport. These are long splices, with the length of the splice about eight inches in this case, securely glued with Curtis cold water glue, obtainable at any airplane supply house, and taped with pinked edging tape which is later doped to bind it.

The brace wiring is of No. 14 wire. The forward struts are 7/8 by 1⅜ in. spruce, bellied a bit for strength fore and aft as the drawing shows. The placing of these may be ascertained by carefully scaling the drawing with dividers. As mentioned previously the longerons and fuselage are shaped up in a rough box mold, and wired and trued to shape.



The wings of the Lincoln Biplane, the plan view of which was shown on page 40 in this issue of Flying Manual, are built in one panel. The dihedral is built in. The spars of the wings are spliced in the same manner as the longerons.

The front elevation will serve to give a very good idea of the trimness of this little ship. The control wires are run as shown in both views, with fittings to correspond to details illustrated on following pages.

Plane Flies Well

In the lower left hand corner of this page you will see the plane built to these plans by Fred Trump, an enthusiastic light plane builder. Mr. Trump's plane is powered with a Lawrence 28 hp motor in which a two throw crank has been substituted to even up the power impulses, thus making the motor a true opposed job. Test flown by Speed Holman, holder of the world's outside loop record and judge of *Modern Mechanics'* Win Your Wings Contest, the little plane behaved well. Considering that Mr. Holman weighs well over 200 lbs., and is about 6 ft. 4 in. tall, the ability of the plane to carry a usual load is well certified!

In the lower corner of this page, a shot of the framework of Mr. Trump's plane is shown. Rather than cut the lightening holes as per strict specifications in the details, Mr. Trump bored out lightening holes as may be seen in this picture.

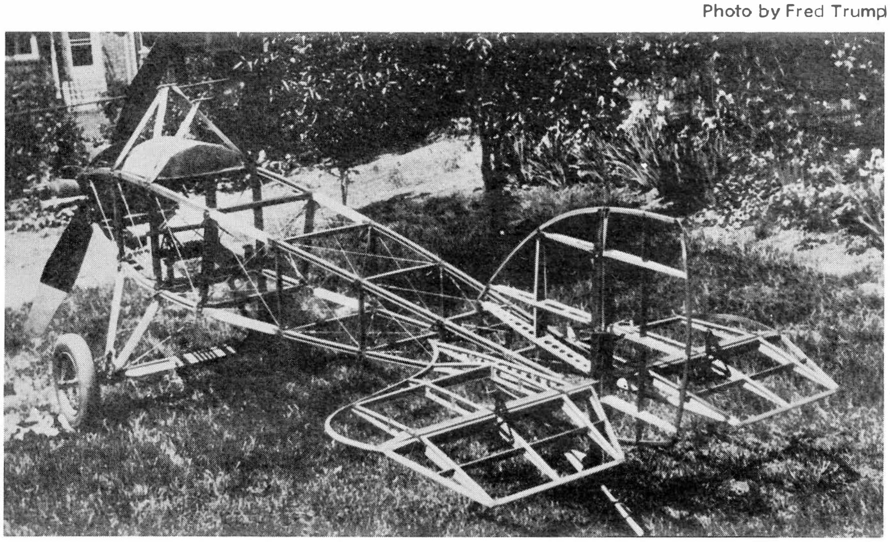
Note that the wings are built in one panel, both upper and lower spars being built according to the wing plan in last issue, and having the dihedral built in. Further details on this construction will follow. The motor shown in the drawings is the 35 hp Anzani which will give the ship a top speed of 100 mph.

Motor Nose Plate

The motor plate or nose plate is the one for the Anzani 35, around which the ship has been designed, and which should be used to get real performance.

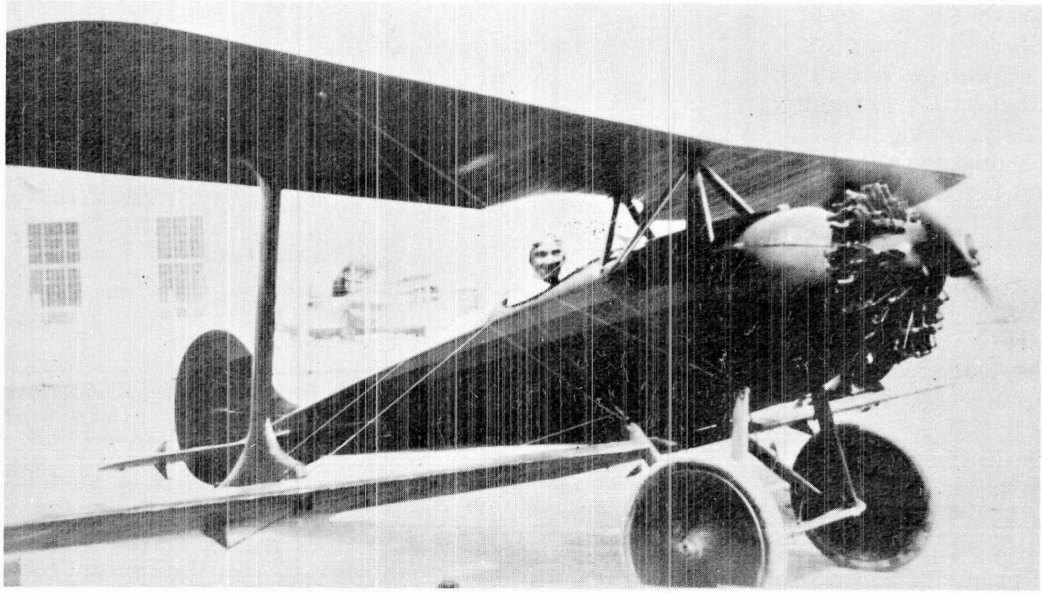
This is of 12 gauge cold rolled sheet steel, which can be cut roughly to shape with a cold chisel or hacksaw, and then filed and bent to final shape. The seam is not welded. The No. 327 turnbuckles, wired to the bay immediately aft, take care of all tendencies for the plate to unfold. Being nearly an eighth inch thick it is solid enough to hold the Anzani nicely. Mr. Trump built a mounting for the Lawrence similar to the one shown for the Alco Sportplane in the previous part. Such a mounting consists of arms of 12 gauge running from either side of the fuselage to the motor

Photo by Fred Trump



The fuselage of Mr. Trump's plane before the fairing was built on. Note the lightening holes in the ribs of the tail assembly.

Photo by Fred Trump



The Lincoln Sport mounting a radial Salmson engine took on the appearance of a first line fighter plane.

Notes on Strut and Wing Fittings For Lincoln Biplane

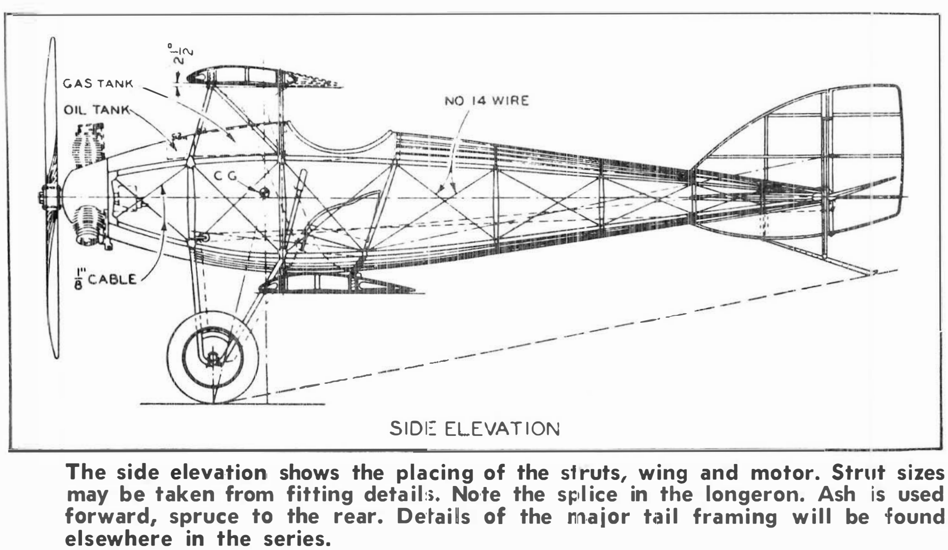
Here are some more of the unusually complete set of details on the building of the Lincoln Sportplane — how the wing fittings and sheet metal work is done.

PART II

Hi, there! How's the Hangar Gang this month? Here we have great summer weather — just the time you feel like getting out on the tarmac and cutting capers with a ship — if you've got one. And why not have one? *Modern Mechanics,* pioneer in presenting plans of all the leading light airplanes of the country, has added another coup to the magazine's list of publishing scoops in capturing the plans of the wonderfully efficient Lincoln Sport Biplane, which can be built from rudder post to prop cap from the plans now appearing in the magazine.

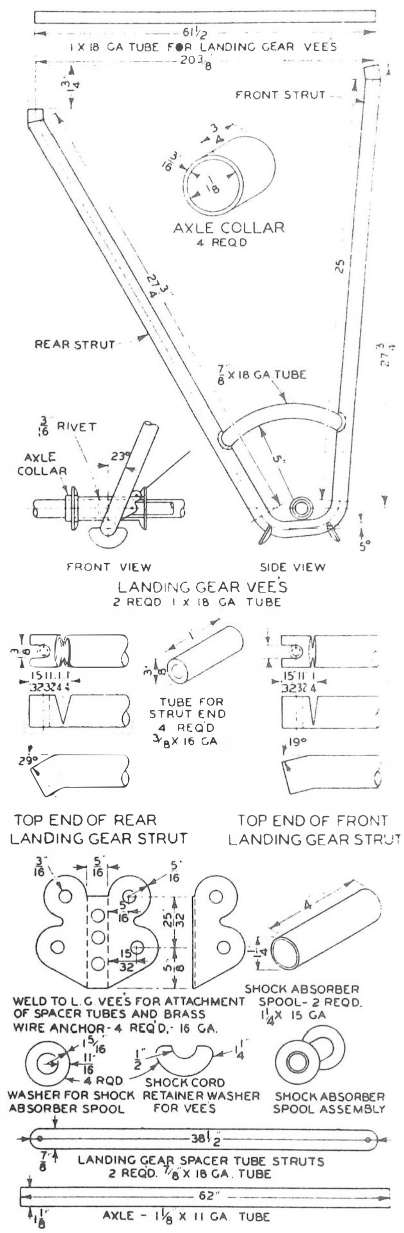
Frankly speaking, as explained in the last part, these plans are not for the rank novice, for rank novices have no business with the building of airplanes. But interest is at such fever pitch on the light airplane question, and so many of you fellows in the Hangar Gang are versed in plane construction, that the completely dimensioned set of plans presented in this Lincoln how-to-build series will give you who are "in the know" all the details you need. The plans as appear in the series are full and complete, just as the designer, Mr. Swanson, of the Lincoln Standard Aircraft Co., Lincoln, Nebr., laid them out. Of course, to tell exactly every move to be made would require a book the size of this issue of the *Flying Manual.*

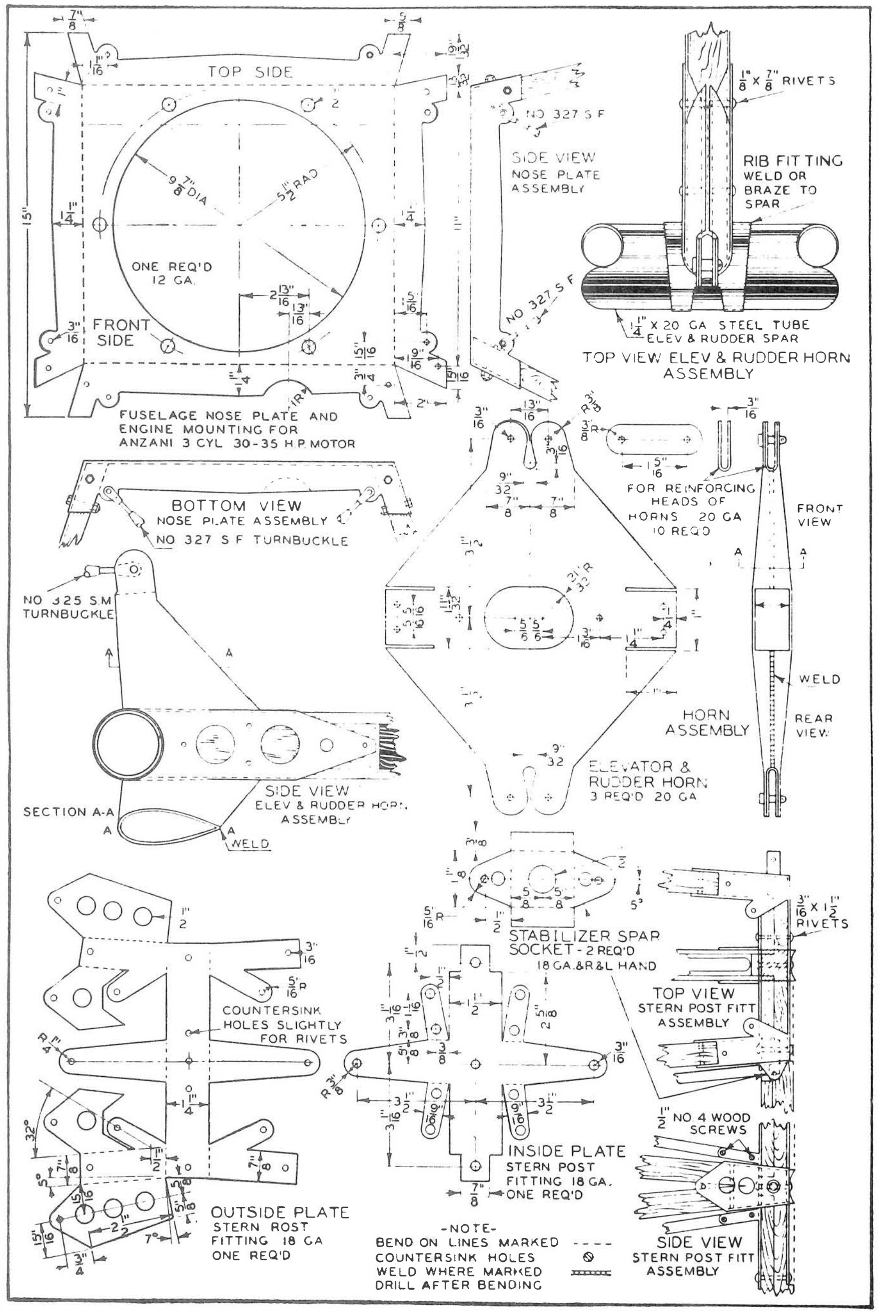
Last part the following detailed plans appeared: Details of fuselage fittings, to scale; blueprint of plan view, to scale, showing layout of the ship and the wing plan in relation to the fuselage; rib plan to scale; interplane strut plan, to scale, and blueprint of landing gear undercarrage. This month further details are set



The side elevation shows the placing of the struts, wing and motor. Strut sizes may be taken from fitting details. Note the splice in the longeron. Ash is used forward, spruce to the rear. Details of the major tail framing will be found elsewhere in the series.

Full dimensions for landing gear metal parts.





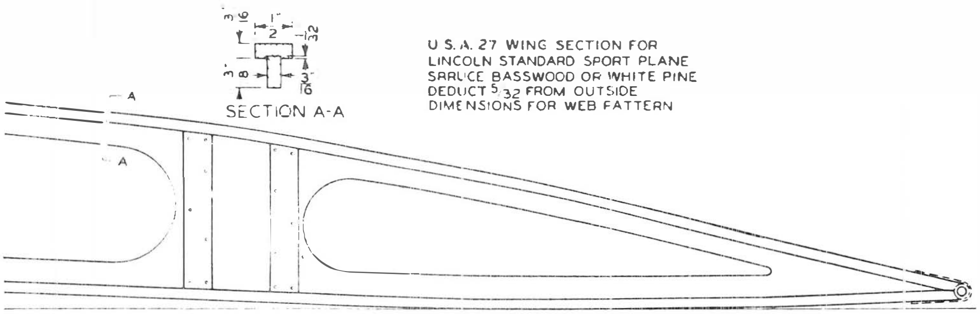
Well designed fittings as shown above provide 11-1 safety factor.

fly any light plane. The two-cycle engine seems to be the coming solution to light plane motors.

The Anzani 35 hp motor, with which the ship in this article is powered, is made in France, and imported into this country by Henry Lowe Brownback and associates, of Norristown, Pa. There are a number of these in the second-hand market and a well-placed want ad will generally bring the required result. These sell for $700 new — a bit out of reach — and for from $200 to $300 second-hand.

As a matter of interest to those aeronautically inclined, let us say that with the power mentioned the Lincoln Sportplane should perform beautifully with the floats which we have had Sam Rabl design, and which can be used with the Parasol, Baby Bullet, or the Russel Henderson, or the Lincoln Sportplane.

Next part a further series of the unusually complete plans for the Lincoln Sportplane will be published, and until then it's "adios!" The editors all wish that more room could be given the plans and description of this plane, but so many good things were calling for space, and the plans for the Lincoln are so unusually complete we have to put some of this good dish on the shelf for the future. • • •



The better way to make the wing ribs is to cut one to shape as taken from the ordinates, making a template which can be tacked over a group of ribs so they may be cut to one uniform size.

all together in one spot, that it is extremely hard to run a how-to-build in split up fashion. However, several details are run in here which must be considered in the building of the ship, and the cutlines will classify them for the subsequent part of the story. Until next time then, gang, make yourselves familiar with the details here presented, getting a clear conception of them, so that next part they will fit into the scheme of things.

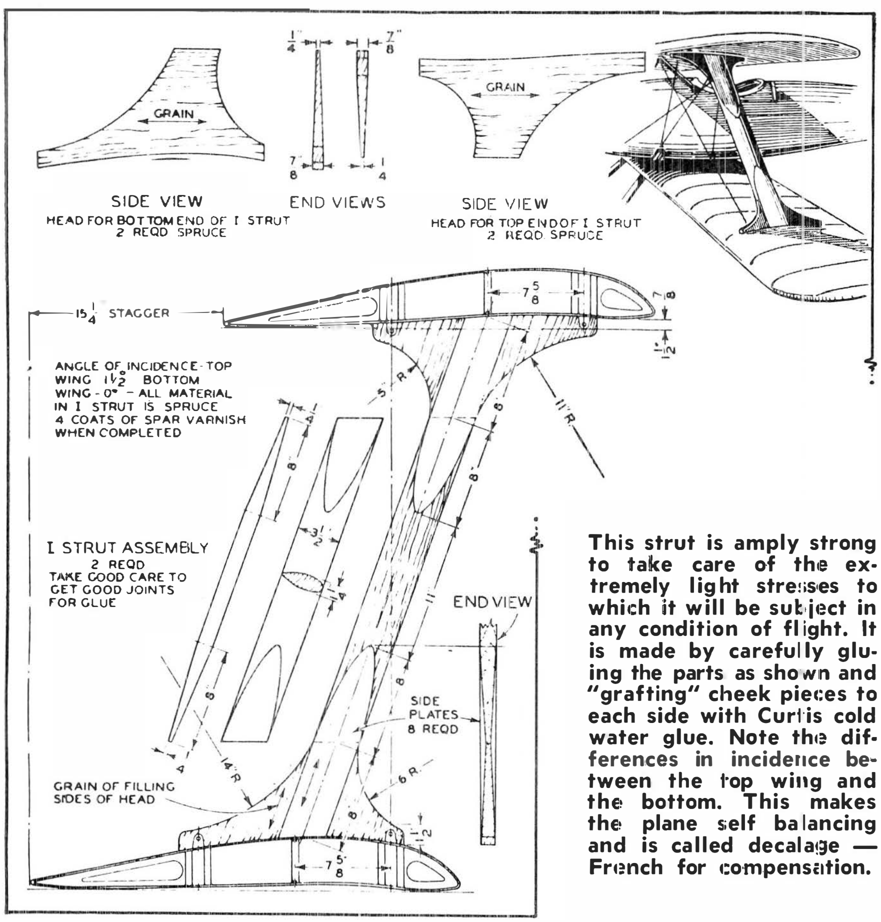
As regards motors for all the light planes which have been published in *Modern Mechanics*, much may be said. There are several types of motors from which the builder may make his choice — V-twin, two-cylinder opposed, etc.

The use of the motorcycle V-twin is not particularly commendable as this writer sees it. When you stop to consider that the average V-twin motorcycle engine develops under ideal conditions on a test stand but 25 hp, and that for but short periods, it is unreasonable to ask these little motors to develop more than 15-20 hp under ideal flying conditions. For one thing, the valves are shielded from the air stream in most designs. The fact that they run hot is also well known. Then, turning up rather high, the propeller efficiency is cut about 10 percent. As the best of props rarely deliver better than 75 percent efficiency, it can be seen that the best the propeller can deliver to pull the ship around is about 12 hp. The motorcycle motors are a bit light for anything save the lightest of ships, such as the Irwin Meteorplane. The Lincoln Sportplane is considerably stouter and needs a stronger motor. The Heath, the Russel, and the Lincoln will not fly well with the V-twin motorcycle types.

The light engine which is available to everybody is the Henderson. The new Hendersons deliver about 35 hp with their new valve arrangement as presented in the 1929 model motorcycles, and with the Heath base, which allows a lot of oil for cooling the motor in conjunction with its lubricating functions, it will make a very good light airplane motor. As remarked in the December, 1928, issue of *Modern Mechanics* and in the Flying Manual published by this magazine, the motor can very easily be converted with the addition of a thrust on the end of the crankcase housing and the shaft for coupling the crankshaft to the prop hub. The Henderson will give the light planes published in this series the same performance as most of the OX5 commercial planes, being loaded about the same weight per horsepower.

As to the Lawrence engine, it is not recommended. The motor was built as a hurried wartime design with a single throw crank, and vibrates too much to allow it to be held in a ship for very long. The servicing problem is a bitter one with this engine. However, by building a two throw crank, and substituting a special cam, they can be made into a fairly serviceable opposed motor. By the time, however, that you get them in shape, you will have spent a lot of money.

The Irwin is a fine little two-cycle engine, but costs $650 at the makers' plant, in Sacramento, Calif. It is light in weight and will



This strut is amply strong to take care of the extremely light stresses to which it will be subject in any condition of flight. It is made by carefully gluing the parts as shown and "grafting" cheek pieces to each side with Curtis cold water glue. Note the differences in incidence between the top wing and the bottom. This makes the plane self balancing and is called decalage — French for compensation.

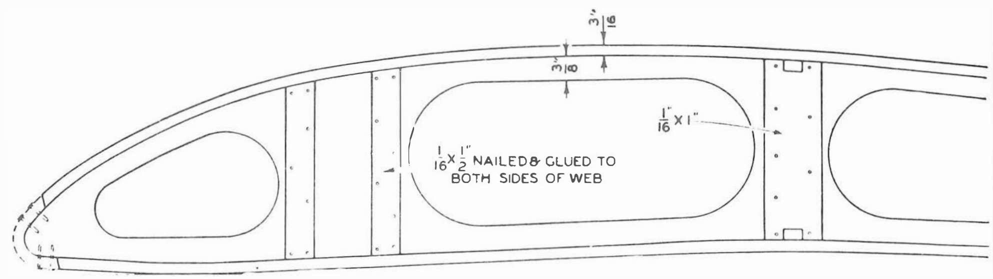
These are of steel tubing and can be worked as shown in the long vertical blueprint, which gives all the details of the parts for the landing gear, short of the wheels and shock cord, which can be installed by anybody. These wheels, by the way, can be purchased from the Lincoln Standard people.

Near the ends of the tubes triangular cuts are taken as shown, using the hacksaw. The ends are bent together and are oxy-acetylene welded.

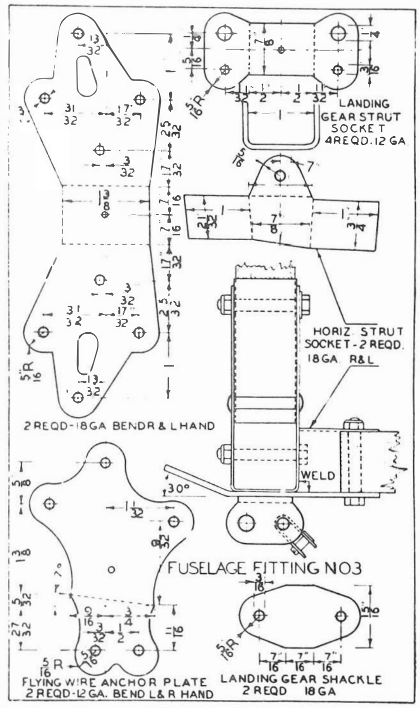
The wing ribs are built as shown, to the standard U.S.A. 27 wing curve. This comes on a further sheet of the plans, as does the wing curve, and shows the ordinates to use for the curve. The drawing shown with the relative sizes of the woods used, gives a clear idea of the type of wing rib used. This is the old, time-tried, strong method of making them out of solid wood and lightening them a little. Such ribs are as heavy as those used in the Jennies and Standards of wartime days, and are far stronger in proportion to the loads which will be imposed upon them, so there is little to worry about on this score.

The wing ribs are built by making a master template, and then tacking together all the thickness of wood for one wing, which is 16 thicknesses in the upper wing and 18 in the lower wing. The lighten holes are all drilled through what will appear to be a solid block of wood, and then light cuts are taken where the spars come. This will mark the spar hole both on the top side and the bottom side, but on four points if the cuts are properly made, and then the cap strips can be put on. This is the best way to make them and will require no jig. The little 1-16 in. tabs are put alongside the spar holes where the down rod goes through, and the rib when given a coat of varnish or two after having been sanded, will be ready to slip on over the spar.

The plans for an airplane seem to be so incoherent until they are



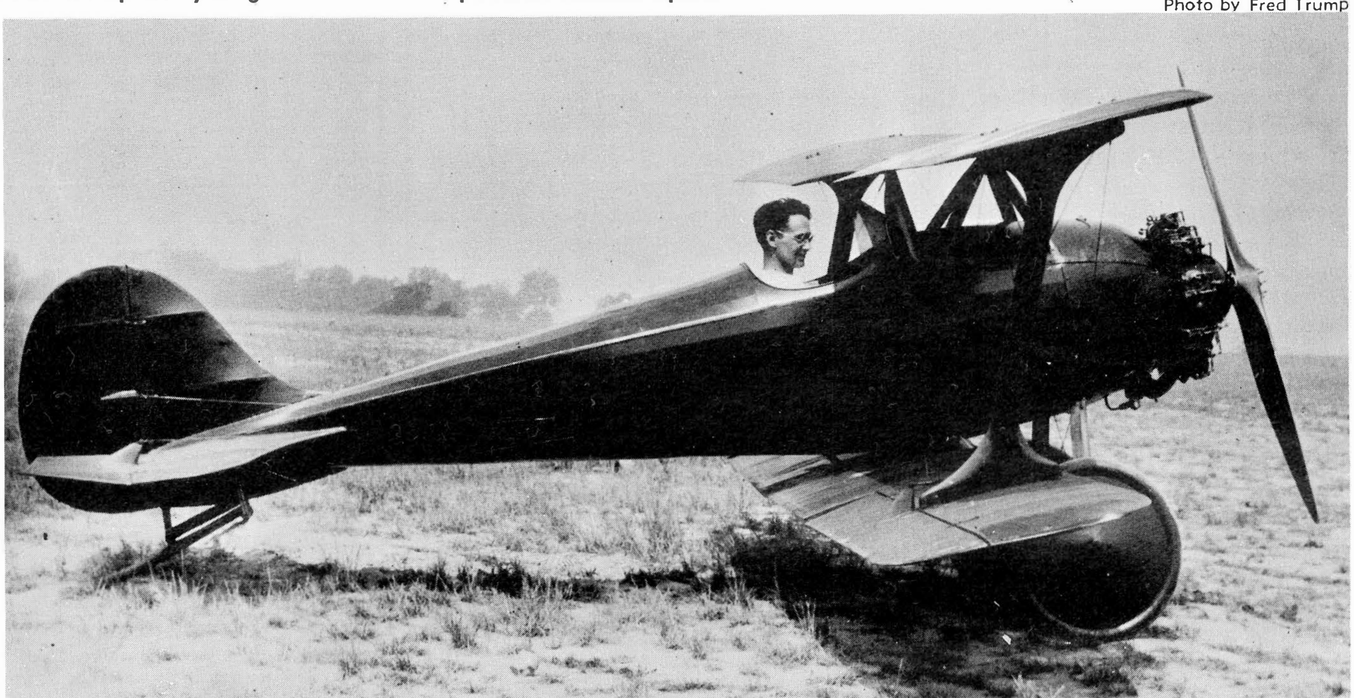
The wing ribs, built to the ordinates of the U.S.A. 27 section, given in the plans in this series on the construction of the Lincoln Sportplane, are of the conventional solid wood type.

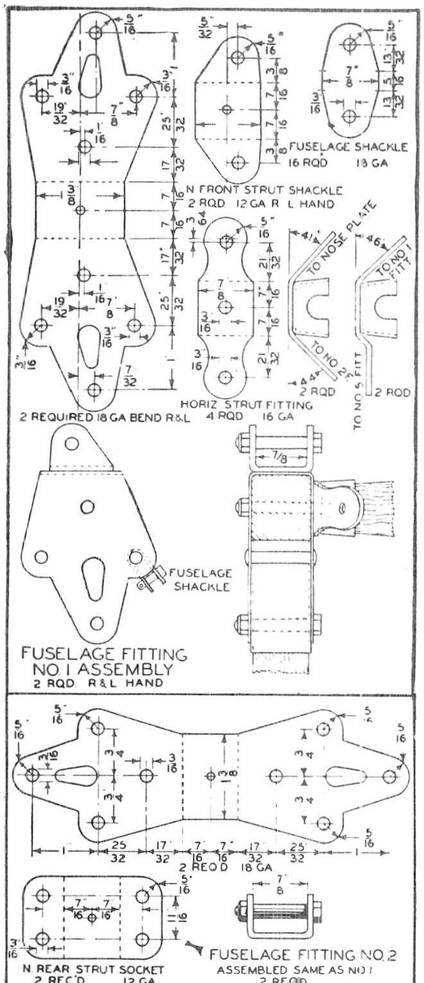


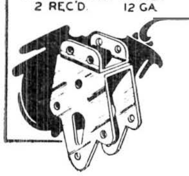
The anchor plate for the flying wires is placed under the vertical and horizontal strut socket.

Fred Trump ready to go in his Salmson powered Lincoln Sport.

Photo by Fred Trump







The details of some of the fittings are herewith shown to give a good idea of the staunchness of the little ship. The use of sheet steel is plainly noted.

In general the layout of the ship is interesting.

Here are the main characteristics:

Span, ft.—20
Wing section—U.S.A. 27
Length o. a.—16 ft.
Stagger—15½ in.
Weight empty—370 lbs.
Weight full load—600 lbs.
Wing loading—51½ lbs. sq. ft.
Power loading—17 lbs. hp
Power—28-35 hp
Max. speed—90-100 mph
Cruising speed—75 mph
Range—250 miles
Climb—800 fpm

This article covers merely general procedure. As there is not enough room to run the full set of plans in one issue of *Flying Manual*, with this installment some of the drawings for the details are included, together with the plan layout. This will enable the reader to get a good fundamental idea of the ship. Each succeeding article gathers up the remarks and details of what has gone before until with the last the reader has the full set of plans.

It will be seen that the gauge used in the fittings of this ship is readily obtainable at the ordinary tinsmith's or blacksmith's shop. The fittings for the most part are very simple and are made of cold rolled sheet steel. When working these in the vise, the proper method is to cut them to shape, drill them and then do the bending. There are some holes, of course, which would be best to work into the bent shape and then drill so that the holes for bolts are in line.

You can see from the wash in the front of this article that the size and general layout of the Lincoln Sportplane are diminutive and conventional. The plan drawing as shown in the blueprint gives, to scale as far as layout is concerned, and the location of the parts, the overhead layout. The fuselage is of wood and wire construction, with 7/8 by 7/8 longerons trussed with number 14 wire. Forward the trussing is the usual ⅛ flexible wire. The fuselage tapers both in plan and form, and instead of the usual vertical tail post, the post is horizontal. This makes for finer streamlining and a ship which resists the torsional effects of rough handling a little better.

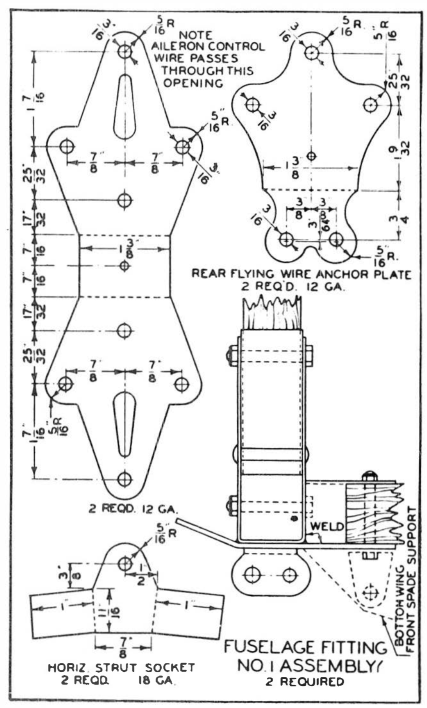
The fuselage longerons are bent to shape in a jig which is made out of rough lumber. It takes the form of a bow with the top side curved to the shape of the bottom of the fuselage. To this the lower longerons are clamped. Then the fittings for the struts are installed, the struts themselves fastened, and then the top longerons are bent down to the fittings placed on the top of the struts. They are fastened and then with the use of the turnbuckles the whole fuselage is trued up. It is faired with pads along the struts and small strips of spruce running along the pads.

Now in this installment you will notice a drawing which shows the peculiar and clever interplane strut which is a Lincoln feature. Not only is it aerodynamically good, but because it is a solid piece, with the 1½ deg. decalage built in, the ship requires practically no truing other than the tightening of the flying and landing wires. This strut, two of which are required, is made up of spruce as the drawings indicate, and before gluing all the parts are carefully fitted and sanded. Use Curtis cold water glue for this strut, clamping with the well known type of shop clamp until the job is good and dry, after about a week's setting.

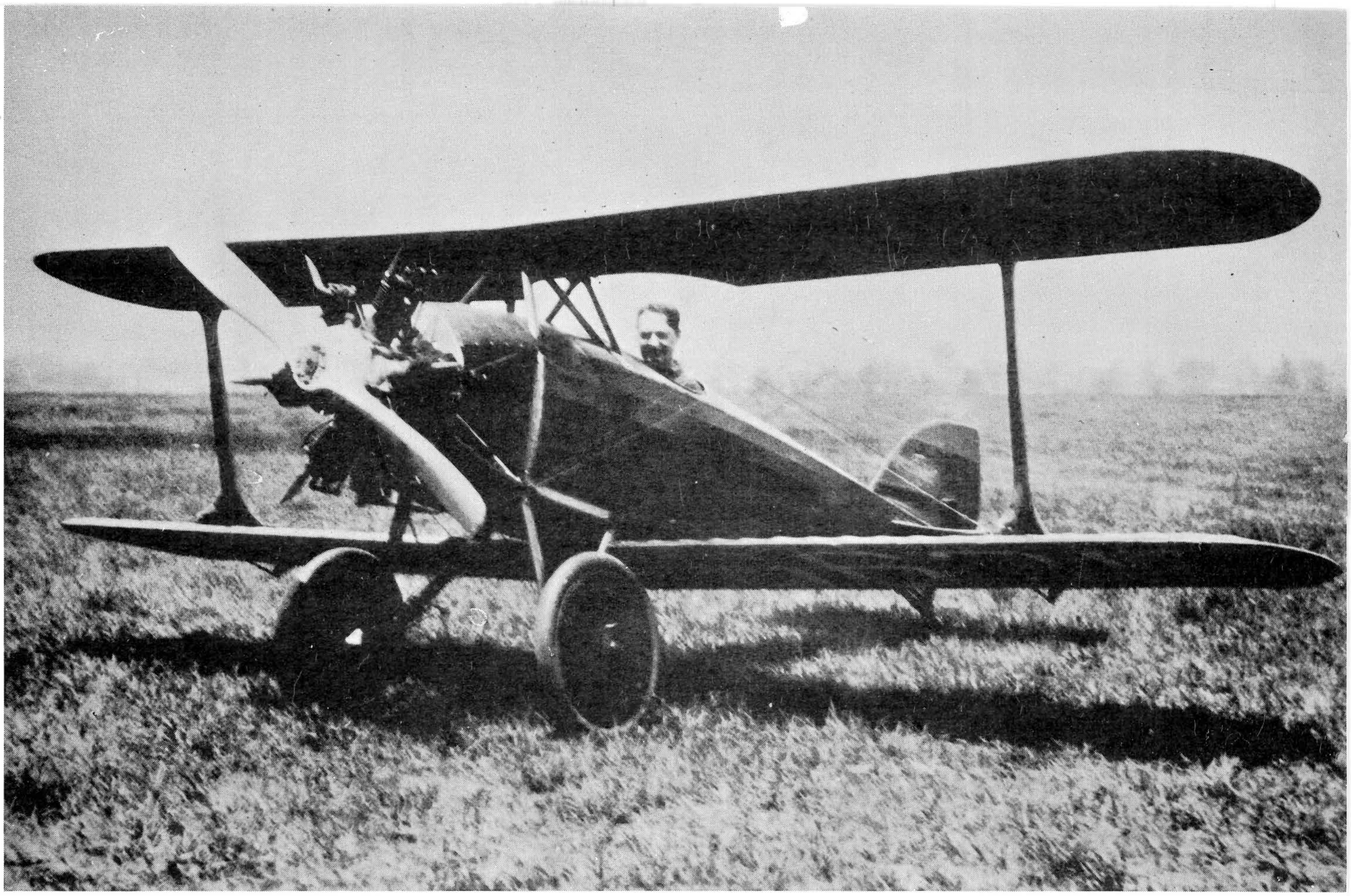
You will notice from the plan view that there is a ¼ in. dowel running through the wing ribs. This is to steady the ribs and keep them from vibrating between spars.

Note the respective directions of the grain in the struts.

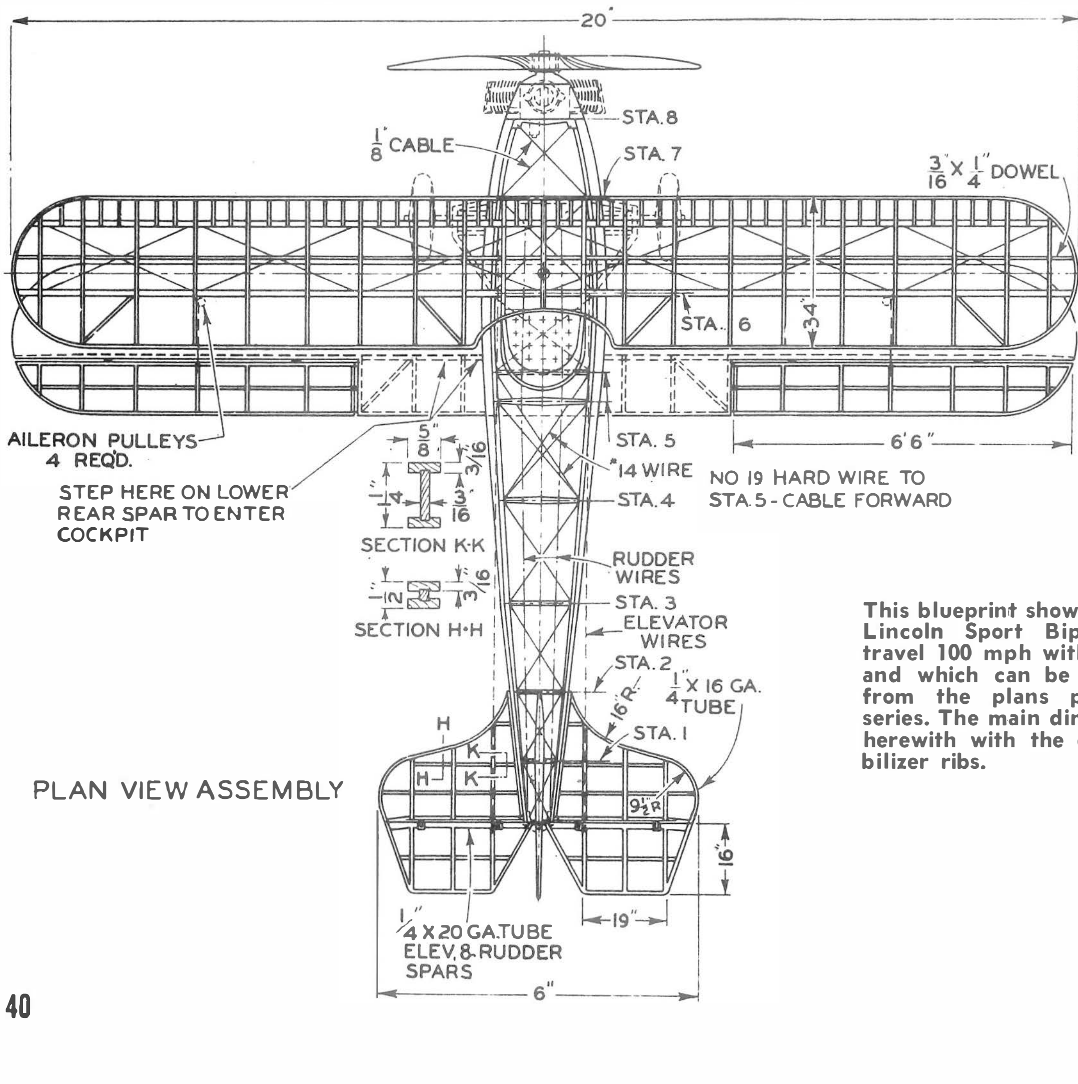
With the fuselage done and the struts made, according to these and subsequent details, the landing gear struts can be made.



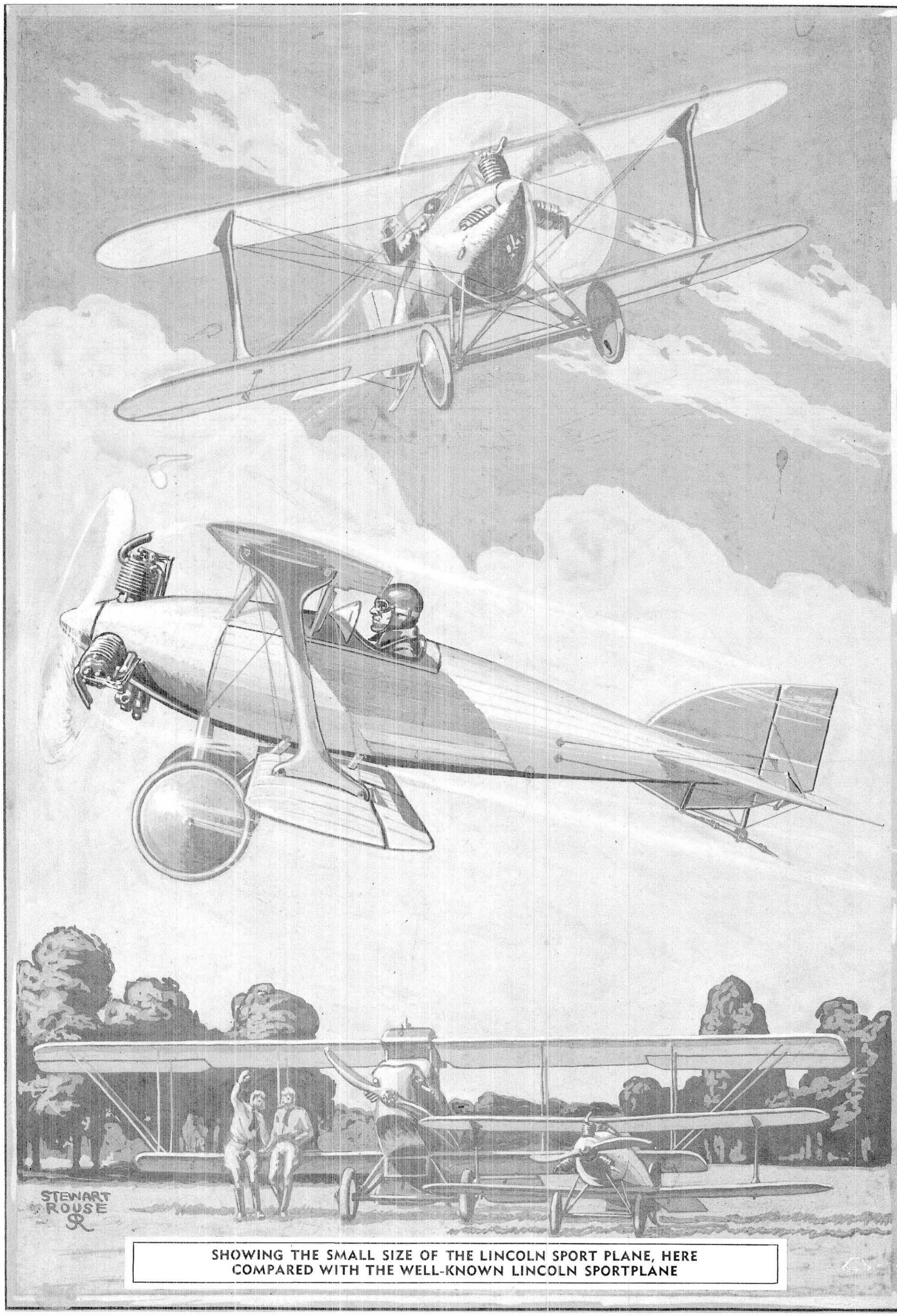
Fittings of the wing clips for fitting the wings to the fuselage are shown in half part here. The article gives hints on bending of sheet metal.



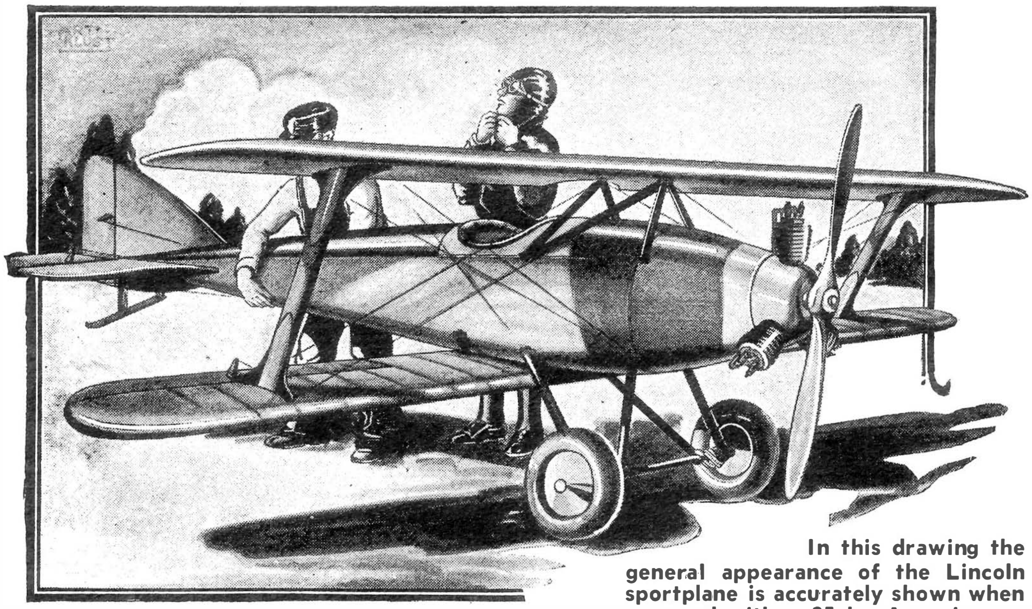
The Lincoln Sport built by Fred Trump sports an Anzani engine. Photo by Fred Trump



This blueprint shows the layout of the Lincoln Sport Biplane, which will travel 100 mph with a 35 hp Anzani, and which can be built by anybody from the plans published in this series. The main dimensions are given herewith with the details of the stabilizer ribs.



SHOWING THE SMALL SIZE OF THE LINCOLN SPORT PLANE, HERE COMPARED WITH THE WELL-KNOWN LINCOLN SPORTPLANE



In this drawing the general appearance of the Lincoln sportplane is accurately shown when powered with a 35 hp Anzani.

Building the LINCOLN BIPLANE

Performing in the same fashion as a modern commercial ship this time-tried lightplane design is the editors' answer to the requests of readers who have wanted a "hot performing" one-place sport biplane.

PART I

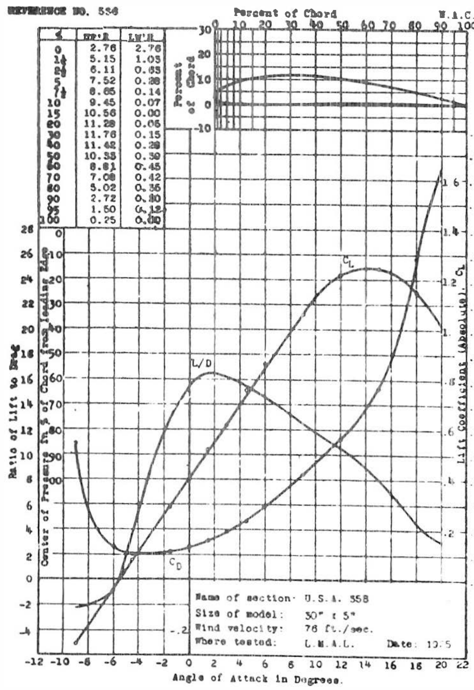
This article takes up the general layout and constructional features of the Lincoln Standard Sportplane, a biplane of diminutive proportions which has been on the market as a knocked-down set of construction parts for several years. The makers, The Lincoln Standard Airplane Co., of Lincoln, Nebr., have sold several hundred sets of parts, and the writer has seen and personally inspected the ship built to these specifications by Fred Trump, formerly of Minneapolis, and now connected with the Keystone Aircraft Works, Bristol, Pa.

The ship is eminently safe, with a factor of safety of 11 to 1, or about 100 percent in excess of the U.S. Department of Commerce present day specifications for type certificated airplanes.

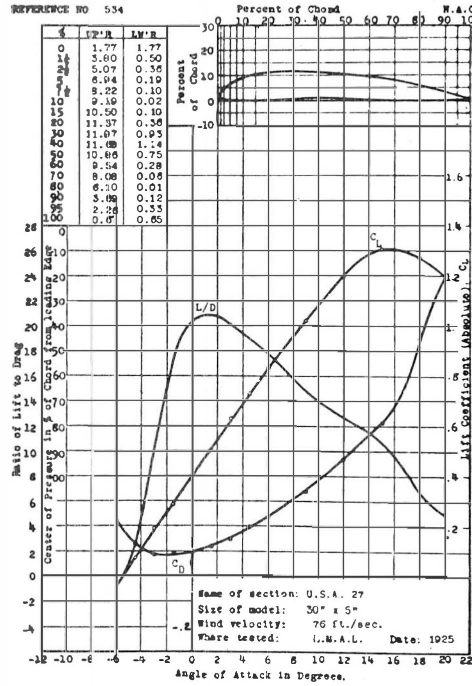
Though the ship was designed several years ago, and stands today a time-tried design of from four to five years of age, it has back of it the designing experience of the firm which built the famous Lincoln Standard wartime planes. Powered with the new Henderson 35 hp F-head air-cooled four-cylinder motor, the ship would have between 70 to 80 mph speed, would fly a useful load of about 225 lbs., and have a ceiling of about 8,000 ft. With the three-cylinder 35 hp Anzani, which swings a big prop at a comparatively low speed, the ship will have about a 100-mile speed and about twice the climbing power and ceiling with the same useful load.

Frankly speaking, this article is not for the rank novice. It contains completely dimensioned plans, in this and the following two installments, and general hints on the building of the ship. To tell exactly every move to be made would require a book the size of this issue of *The Flying Manual,* and even then would presuppose some knowledge of aircraft construction on the part of the builder.

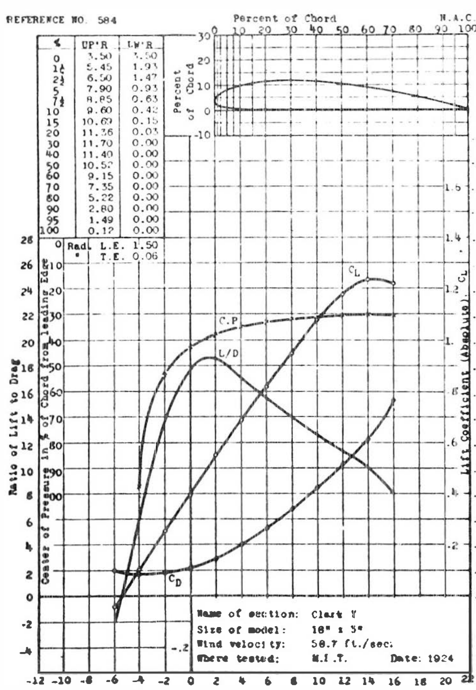
However, any bright lad who has access to the experience of a licensed pilot can build this plane with the occasional help he is able to receive from the pilot, and the completed ship will be safe and reliable in the extreme if the plans are followed to the dot. For those who wish blueprints, a five dollar bill sent to Lincoln Standard Aircraft will bring a neat, complete set of prints, which though they give no more information than shown in the working drawings here, may help when it comes to actual shop layout. This article, then, furnishes all working dimensions needed for anyone fairly familiar with airplane construction to build his own plane. It is not an a-b-c how to build article, nor is it intended to be such.



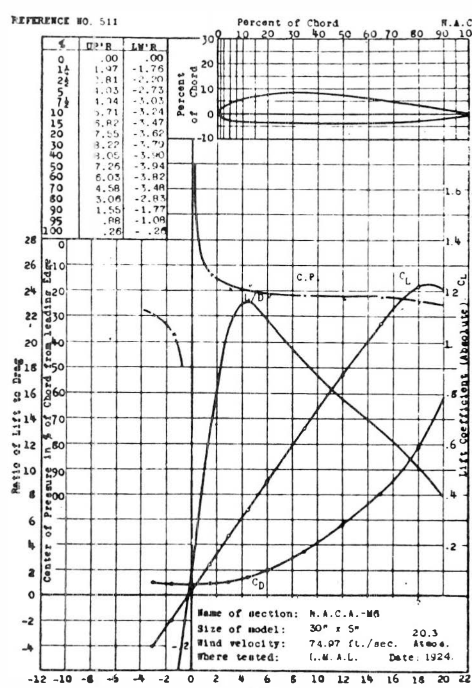
This is the U.S.A. 35B, around which the formulae in the article are written. A good all purpose wing.



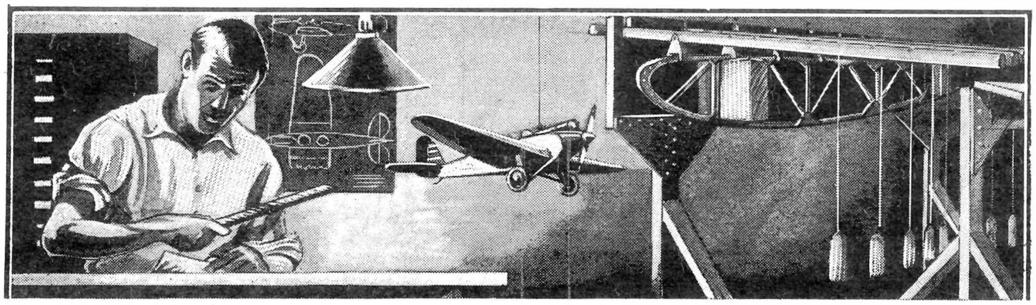
This is the wing section used on all Waco models. It takes off faster, climbs slower than the Clark Y.



The Clark Y used on Ryan monoplanes. Good stability and speed are characteristic.



This is the N.A.C.A. M-6 which has negligible center of pressure travel. A favorite for small monoplanes. Very stable.



By an interpretation of the simple formulae shown in this article, anyone fairly proficient with arithmetic and elementary algebra can readily determine the wing section to use in his own designs.

CHOOSING YOUR OWN WING CURVE

The National Advisory Committee for Aeronautics has collected and published data on wing sections that have been tested in various laboratories all over the world. These reports are given in NACA reports numbers 93, 124, 182 and 244. They have also tested a number of wings in their own variable density wind tunnel and give these results in reports numbers 221 and 233. It is the belief of the writer that only these later results can be relied upon since they were obtained under conditions equivalent to full scale.

Two systems of units are employed in these series of reports. In reports numbers 93 and 124 the English system of absolute units is employed; in the remainder the German-American system is used. It happens that the values of the lift and drag coefficients used in reports numbers 93 and 124 are just one-half as large as those used in the remaining reports.

In the English system the lift coefficient is denoted by Lc and the drag coefficient by Dc which are defined as follows:

$$Lc = \frac{\text{LIFT}}{\text{CSV}^2} \qquad Dc = \frac{\text{DRAG}}{\text{CSV}^2}$$

In the German-American system the lift coefficient is denoted by C_L and the drag coefficient by C_L defined by

$$C_L = \frac{\text{LIFT}}{C/_2SV^2} \qquad C_D = \frac{\text{DRAG}}{C/_2SV^2}$$

On the curves given in reports numbers 90, 124, 182 and 244 are plotted four quantities all against angle of attack from the tangent chord line. These quantities are the lift coefficient L_C or C_L, the drag coefficient D_C or C_D, their ratio or L/D and the position of the center of pressure.

Since the maximum L/D depends upon the value of Cs as shown in formula 5, and since the value of Cs should be a minimum for good sections, a wing that has a large value of L/D and a large value of C_L or L_C maximum will be the best. It is a matter of simple inspections of these curves to determine these quantities and therefore to choose the best wing of a series.

Very little use is made of the angle of attack except for reference and to enable the designer to place the wings on the fuselage in such a manner that the body will be level when cruising.

Problem 6. Find the angle of attack at which the airplane is flying in problem 2.

From problem 4, the value of C_L is .763

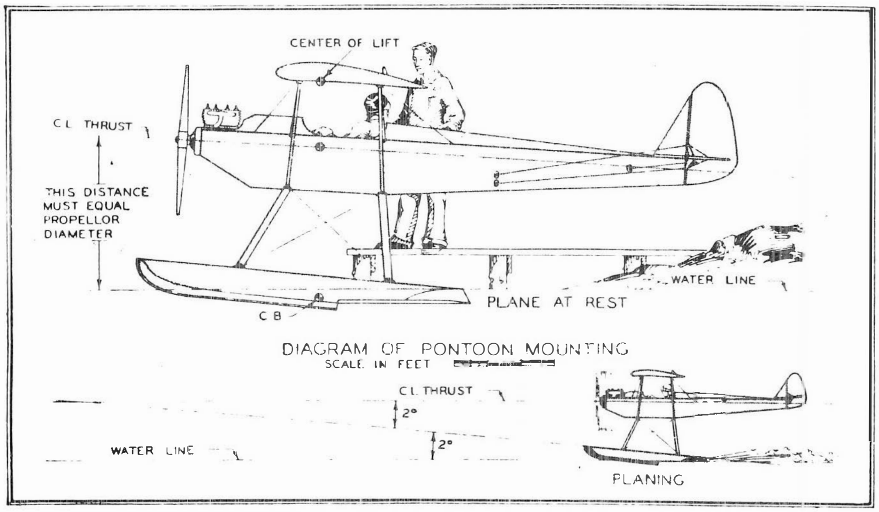
By reference to report number 182, and the plotted results of USA 35B, wing section reference number 487, reading C_L = .763 on right side of plot and extending a line horizontally until it strikes the curve of C_L, and then a line vertically downward to read angle of attack we find the angle of attack corresponding to this value of C_L is 5°.

EDITOR'S NOTE: For reference to above formulae see article "Why An Airplane Flies", by Ivan S. Driggs in another issue.

the limit allowing practically no excess horses for the speed necessary to lift the ship. This same condition may result due to the engine not delivering sufficient revs to the prop so we must try to coax her up on the step. Shove the throttle up until there "ain't no mo';" shove left and let the plane race forward with tail high. Give the stick a quick yank back and shove 'er forward with the same alertness. If she doesn't come up on the step with this treatment try rocking her back and forth with the elevators until some time when she may grab the top of the water and decide to plane. If you get her to planing let her run a while to gather speed and zoom her up. If after all of this treatment she won't respond to kindness you may run her ashore, tell her all the words you know and then and there decide to put in a larger motor or turn her back to a land plane.

Just a word on the weights on these floats, for it was this feature that led me to design the center girder type and I had made an analysis of the two types of construction before I wrote this story. I generally outline the main parts of it as a series of notes and my notes have this feature in them. I guess in the rush it just naturally slipped my mind until now.

To avoid down loads on the tail the pontoons have to be set to exactly the right angle. This sketch shows the manner in which the incidence is set, and how to load the pontoons under the center of lift and gravity. A tail float might prevent upsets while at anchor.

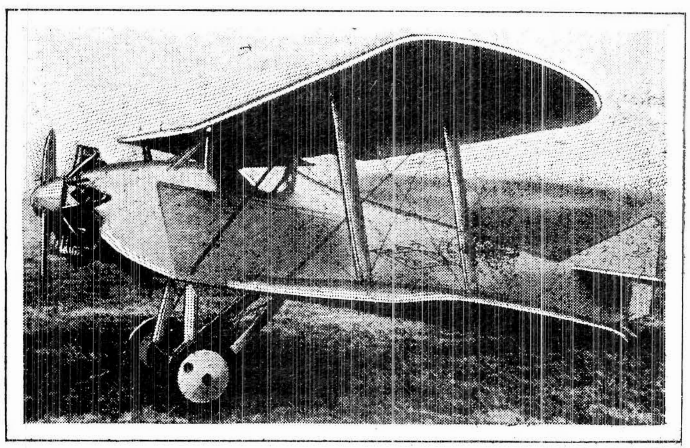


Here they are for both types, the weight for a single float. It would be impossible to accurately estimate the struts as they will be different for each individual design of plane.

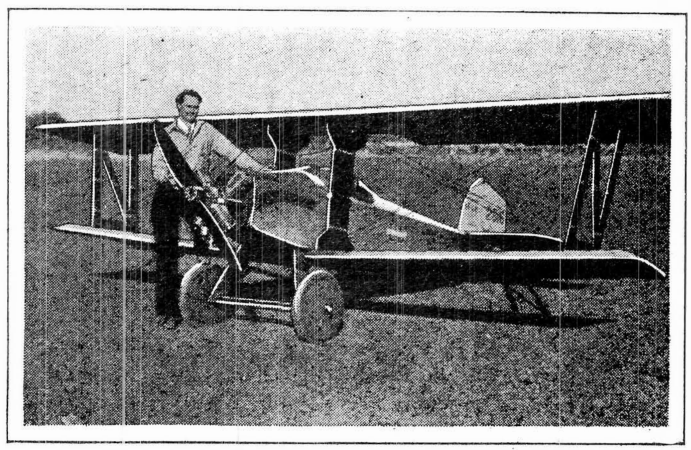
No. 16 ga. throughout and *no center girder;* skin, 28.29 lbs.; bulkheads, 5.52 lbs.; total 43.81 lbs. Plans not shown here.

Thickness as specified and with center girder; top skin, 11.44 lbs.; bottom skin, 8.25 lbs.; bulkheads, 5.52 lbs.; center girder, 7.32 lbs., making a total of 32.53 lbs. per float or a saving of 22½ lbs. on two floats.

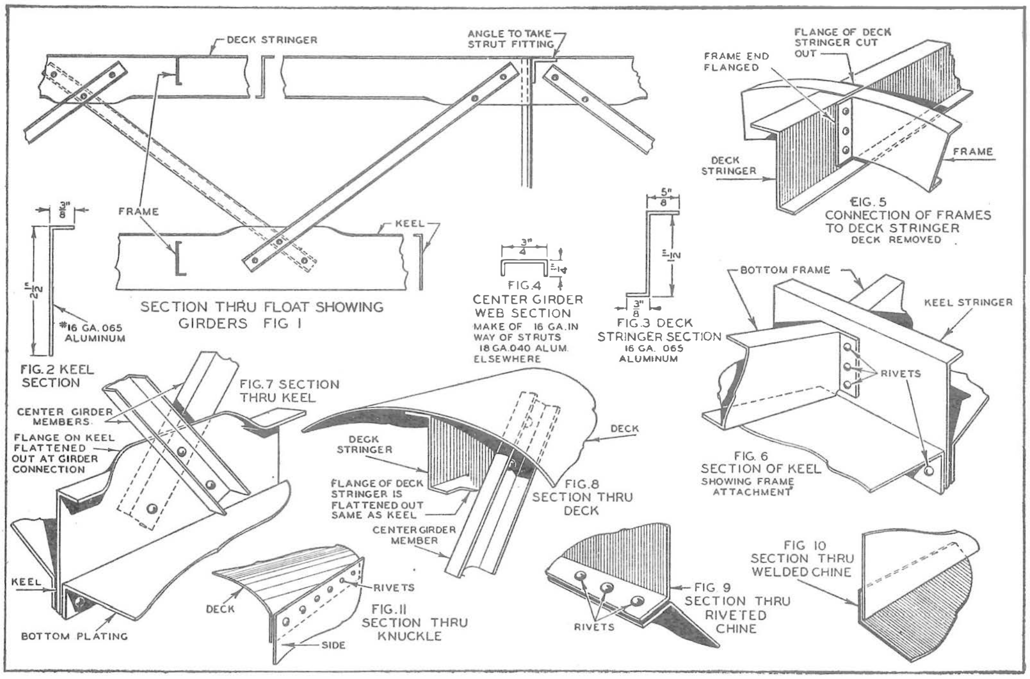
As Weston Farmer explained, the greatest amount of power is required to get her over the hump and after that it's easy. He is working on some light flying boat designs. While he is doing this you may rest assured that this thought foundry will not be idle and we are collecting data and devoting our time to research and at some not far distant date I will discuss the different types of flying boats and their possibilities. Until then goodbye and don't get wet feet. •••



Gates R.S.V. plane—Convertible into either monoplane or biplane. Photo shows it as biplane; lower wings and struts can be removed to leave it a semi-cantilever monoplane. This feature enables the plane to be used as a training ship which will permit the student to convert it into a high performance monoplane after he has built up enough flying hours in it as a biplane. Motor is Renard 120 hp. High speed is 102 mph; landing speed, 35 mph. Gas capacity, 20 gals., wing area, 280 sq. ft.



Meteorplane — built by Irwin Aircraft Co. Powered with Irwin 4-cylinder radial air-cooled motor weighing only 60 lbs., and developing 25 hp. The baby plane is only 12 ft. long and but 4½ ft. high. Wing spread is 14 ft. 6 in. It accommodates a disposable load of 300 lbs. High speed is 90 mph and cruising speed is 75 mph. Climbs 400 ft. in first minute. Service ceiling, 12,000 ft. Fuel capacity is 8 gals., giving a normal cruising range of 300 miles. Normal fuel consumption, 1.7 gals. per hour.



This wonderfully instructive and complete article by Sam Rabl, is a course in itself on the construction of up-to-date aluminum pontoons. Details of the riveting, of the channels used, and of the weights of aluminum used are pictured above. Tinsmiths' tools are used to make these floats.

Getting back to the rivets again—they should be of soft aluminum and easily worked. Speaking of soft aluminum, be sure that the material in the skin of your floats answers this description before you start punching holes in it with a nail set. If it is not soft it might be better that you forget that punching racket and provide yourself with a nice electric drill for it will sure come in handy.

Any riveted joint that is to be water-tight should be riveted with a spacing that is no greater than three times the diameter of the rivet. You may go to three and a half times the diameter where the flannel is used in the seams. In other words using rivets 3/32nds in diameter a joint that does not have flannel should have the rivets spaced 9/32nds apart and one using flannel may be spaced 7/16ths. Be sure in riveting the seams that you do not scar the soft aluminum with the hammer in the peening operation or in setting up the heads.

The whole interior of the float should be given a coat of bitumastic paint, obtainable at all paint stores, and a hand hole should be provided over the step so that the float may be drained.

In setting the floats on the Heath Parasol or the Russell or that superb Baby Bullet, be sure that the center of gravity of the plane is set directly over the center of buoyancy of the float in loaded condition and that the centerline of thrust noses down 2 deg. to the top of the float. This condition gives the float a planing incidence of 2 deg. when the centerline of thrust is level. Of course we could set both the top of float and centerline of thrust parallel and get our planing angle by pushing back on the stick and throwing the tail down but this imposes a down load on the tail and with the little bit of reserve power available we better try to eliminate all down loads.

Remember always that in converting any of the planes that *Modern Mechanics* has published as land planes into hydros we are taking them off their element. They were designed to operate off the ground and while it is true that the floats will be of very little more resistance than the landing gear the fact that their weight eats up a big glob of the useful load cannot be denied. In the Simon-pure flying boat the hull forms the float and fuselage combined without the parasitic resistance of the struts to the floats.

Now let's get them on the old crate and see what she will do. If you are ready to climb aboard DON'T crawl up her tail into the cockpit unless you have a crane supporting the stabilizer. It is next to impossible to design a float that will take care of the CG as far aft as it would be if you straddled the fuselage aft of the cockpit. Have some of the shore gang hold her when you get in and play safe. Another don't: *don't* get her head into a brisk wind. If the rear end of the floats bury and the wind gets under those high parasol wings she will sail over backward and she would not be the first one to do it. A tail float might help a bit until you get used to handling her. This danger will not be present in the Baby Bullet as the proportion of the tail length behind the floats will not be as great.

Well, now that we are aboard, let's get started. Rev the motor up to full speed. When you have a clear path head into the wind and let her tail come up. Keep it high until you feel that there is someone gently patting the bottom of your floats "She's Planing!" Dip her tail and she's off. Maybe it won't be as easy as this. Remember the trouble Amelia Earhart had in getting the Friendship off, remember of reading of the long runs that were necessary? Here was the trouble. The plane was loaded to

strut or one of the bulkheads.

Before the center girder is assembled we must slip on the strut bulkheads so we will take up their construction before proceeding with the center girder.

A maple block is cut out to a shape which will allow 1/16th of an inch clearance all around the bulkhead and all the openings. The block should be about an inch thick and laminated if possible. This forms the die for our bulkhead. The material for the bulkhead is next cut to shape allowing a half inch around the outside of the block and one half inch inside of the openings and we are now ready to make the flanges.

After rounding the edges of the block to an eighth of an inch radius the metal is clamped to the block and slowly peened down around it with a *wooden* mallet. We should take extreme care that our aluminum does not become hardened by this peening process and if the least sign of a crack appears the metal should be softened or annealed by applying the flame from a gasoline torch to the metal.

After flanging, the openings for keel and deck stringer are cut and a channel riveted down the center of the bulkhead as shown. Another channel is riveted to the bulkhead to transmit the force of the thwart to the center girder. *Do not try to bring both these members to the same point to avoid torsion strain on the fitting.*

The bulkhead is now riveted to the center girder by means of little angle clips on each side of the girder.

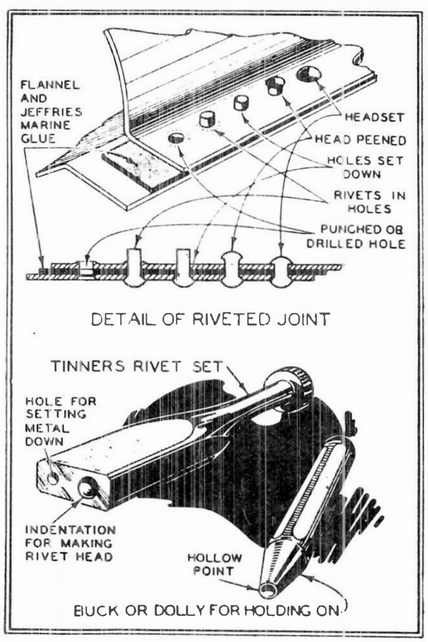
The frames are now formed around a block in a similar manner to the bulkheads with the exception that the bottoms of the frame are made on a brake as were the keel and deck stringer. The attachment to the center girder is the same as was the bulkhead except that the flange of the frame takes the place of the angle clips as shown in Fig. 5. The attachment to the keel is made in a similar manner as shown in Fig. 6.

Let us now lay the frames aside and proceed with the center assembly. The web members are next riveted to the keel and deck stringer as shown in Fig. 1, Fig. 7, and Fig. 8 and with the fastening on of the frames we are ready for the top skin.

The skin of No. 20 gauge aluminum .032 thick is now developed, and formed approximately to shape with the chine flange and the knuckle bent as shown on Figs. 9, 10, and 11. It is riveted to the frame, bulkhead and stringer flanges with 3/32 in. aluminum rivets spaced about 1½ in. apart. Be very careful that the rivets are up tight as these must be water-tight.

While we are on the subject of the top skin, let's discuss the chine. The angle flange of the chine or edge where the bottom and sides of a float or a boat meet, should be varied so that at the nose it is exactly level and so that at amidships it forms a 45 deg. angle to the sides. This form of chine prevents the formation of bad spray and greatly stiffens the edge of the float.

The bottom is easily assembled with the form of chine mentioned above as all riveting is done from the outside, no rivets being driven through the bottom flanges of the frames.



The method for setting the rivets conforms to the well known tinner's method. The rivets should be spaced not over three and one-half times their diameter. Use flannel in the seams.

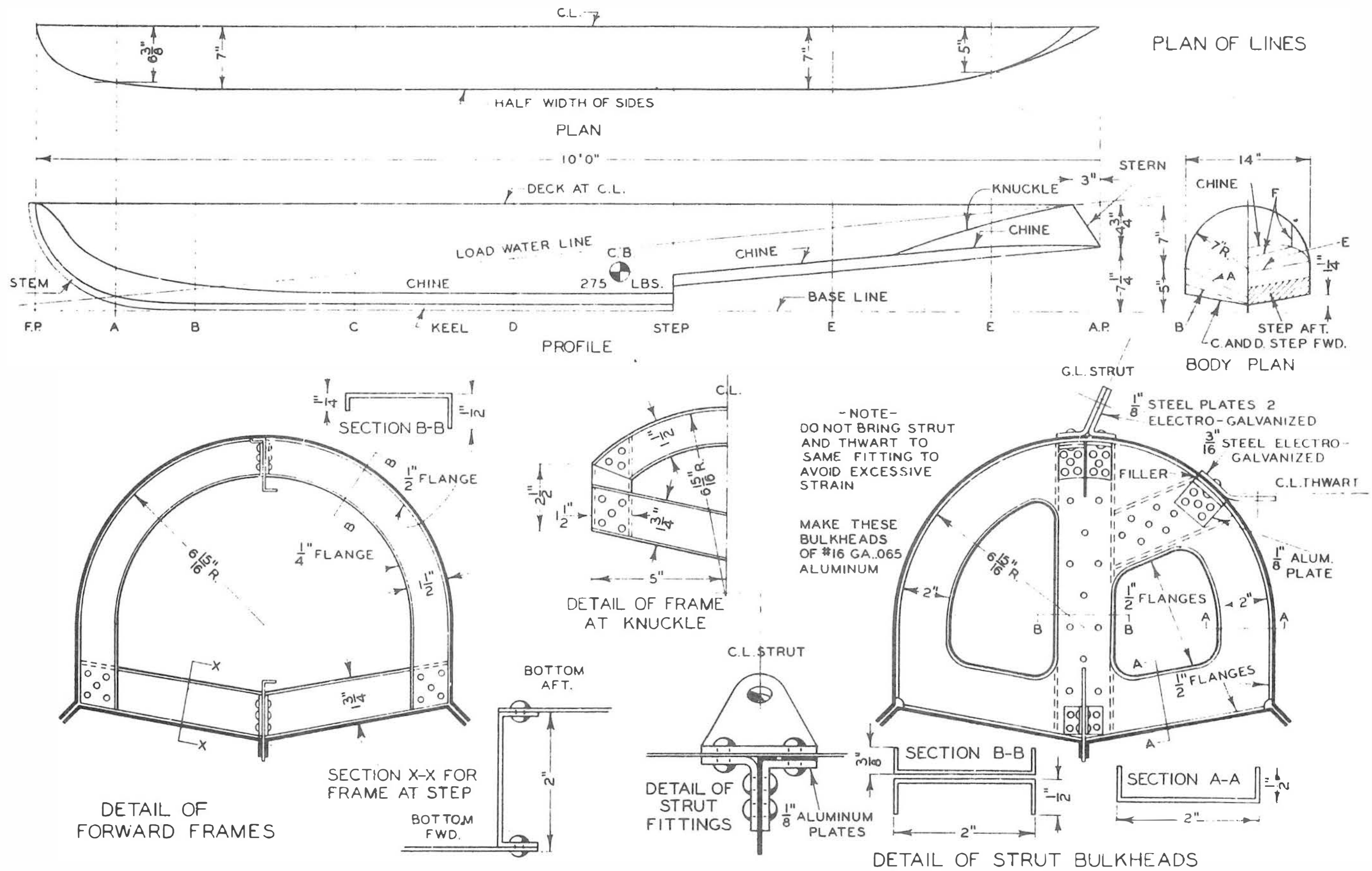
The bottom of No. 18 gauge aluminum is next gotten out to fit the shape of the float and laid aside until we fit the strut and thwart fittings. These are made of steel, as shown on the plans, to the correct angle and bolted through the ⅛ in. aluminum reinforcing plates inside the hull with steel bolts, all of which should be electrogalvanized or zinc plated, and then we are ready to rivet on the bottom plating.

A strip of flannel soaked in bitumastic paint should be placed between all water-tight joints of keel and chine as well as any joint of the step or shell that is exposed to water and the whole float given a coat of bitumastic paint.

The struts and thwarts are made of 2 in. Kawneer steel *streamlined* tubing with flattened ends to suit the conditions of your plane in a manner similar to that shown on the sketch, and by the way, in making the twin floats *be mghty sure that they are made right and left hand* or grief will result. Two right or two left hand floats will do you no good.

The riveting of the aluminum seams should present no great difficulty. One of the best methods of hand riveting is the old and tried method in use by tinners the world over. A hole is punched with an ordinary nail set, the rivet is inserted and a tinner's rivet set is used to set the hole down by slipping the hole in the set over the rivet and giving it a whack over the bean with a hammer. The head of the rivet is next peened down with a ball peen hammer, an operation soon learned with a little practice, and then the head is neatly rounded with a little hollow provided in the set for this purpose.

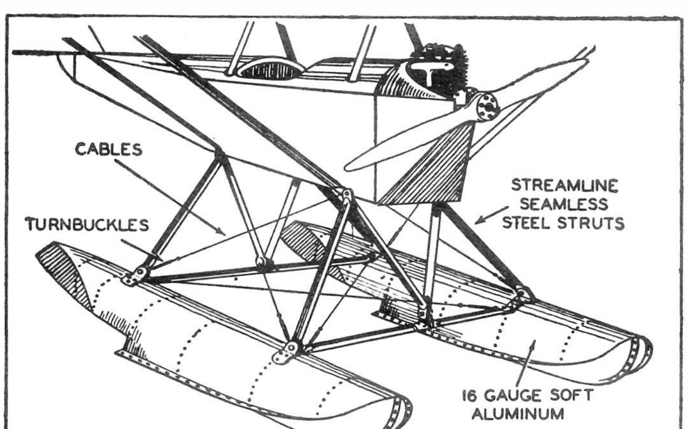
If the foregoing jargon is as yet inunderstandable, any tinner will be glad to show you just how it is done. Of course, you know that a good cigar or a bit of schnapps will go a long way in promoting friendship with a tinner!



force of rough landings on this part of the float.

Well, let's get into the actual construction. There are two methods of fastening our aluminum material from which the float is constructed. We may have it welded (if we are rich) or we may rivet it ourselves if we are the average lightplane bug. In either event let's start with the centerline girder.

Westy Farmer has told us just how to place the center of gravity of the plane over the center of buoyancy of the float. This is to be a design of float suitable for all of the lightplanes under the 550 lb. mark it is evident that the points of attachment of the landing struts will not be the same of any two of them, therefore, we cannot give a design of centerline girder that would work for every condition. *The point of prime importance is to locate a strut bulkhead under each point of attachment* where the struts come down from the fuselage, and space our frames in between these points. There is no absolute necessity for an *equal* spacing of the frames; anything from 12 to 18 in. will be sufficient.

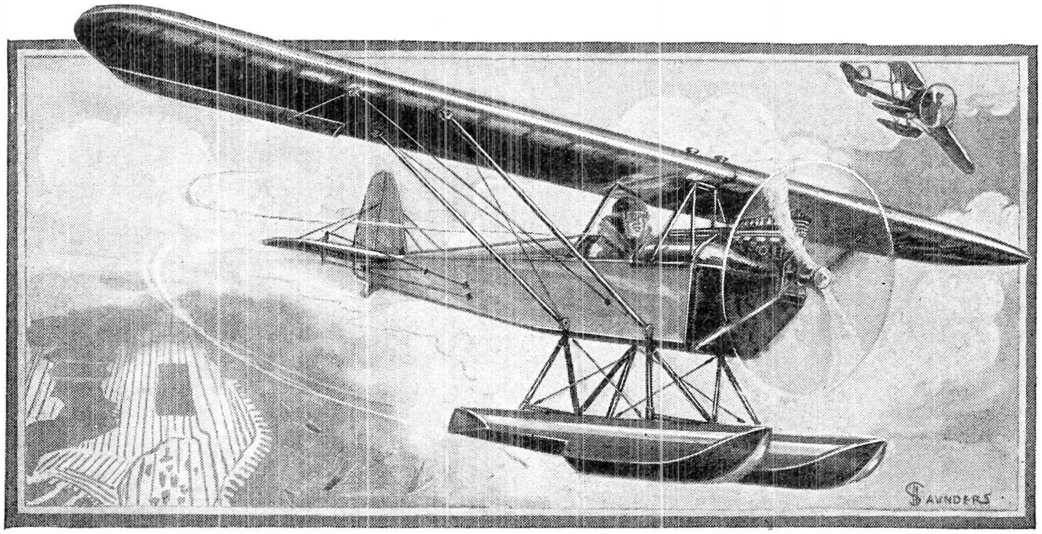


Note that the strut attachment fittings do not come at coincident points. They are separated so as to avoid concentration of landing stresses. It is a good plan to varnish the floats.

The web members of the girder are now located to join the deck stringer at the strut bulkhead and to miss the point that the frames are attached to the stringer and keel. Forward of the first strut bulkhead and aft of the last strut bulkhead the frames and web members are spaced to the keel and deck stringer. A drawing of all the component parts is shown in Fig. 1.

To further explain the center girder construction let us take each of its component parts separately. The most important part of the center girder is the keel which is constructed from No. 16 gauge aluminum and flanged as shown in Fig. 2. This operation may be done on any tinsmith's brake if the forward part which forms the stem is spliced on where the curve commences.

The deck stringer is made in much the same manner of the same material as are the center girder web sections with the exception that they may be reduced to No. 18 gauge where they do not meet the deck stringer at a



The trim appearance of the Heath Super Parasol, one of Modern Mechanics' how-to-build airplane designs, when equipped with the Rabl floats is shown in this picture of the plane above Manhattan.

BUILDING A SET OF LIGHTPLANE FLOATS

Here are the long looked for Pontoon plans, which the Hangar Gang has eagerly been waiting for. Mr. Rabl, versatile naval architect and designer of floats for the Glenn Martin Aircraft Factory, has given us the first complete float design ever published.

by Sam Rabl, Naval Architect

This article shows the design of a set of floats that can be used on any lightplane weighing not over 600 lbs.

As Weston Farmer says, "The itch to fly off the water cannot be allowed to grow into a pain," so herewith we present the cure for any growing itch. If we were not familiar with the requirements of a hydro float and only considered the naval architect's side of the matter the design of a lightplane float would be a simple matter indeed. If we are to supplement the flotation qualities with requirements of flight the process of design becomes a bit more complicated.

First of all a seaplane float must combine with light weight a ruggedness that is not found in the average water craft of the same size. It must also have good aerodynamic qualities so that the power required to move it through the air will not eat up the relatively small reserve that a lightplane is cursed with.

The float must possess great longitudinal strength which may be incorporated in the design of its skin or in a central girder which is the lighter of the two methods. It must also have a certain amount of transverse strength which in any event must be supplied by the process of building frames inside the skin. There are also points along the hull of the float which are subject to greater strain which must be taken on heavy frames called bulkheads.

If we examine the plan of the lines herewith we find three views of half of the float, the right hand side to be precise. At the top of the drawing we see the plan which gives us the shape of the float horizontally. Below this we find the profile which depicts the vertical shape and to the right we find the body plan which is a series of transverse sections through the float. A closer examination of the design will reveal that the top is a complete half circle with a flat side for a short space below it. The bottom of the float has been given a slight rise so that the bottom frames will not have to be as deep as they would if it were absolutely flat, a condition which finds an analogy in the construction of a roof truss.

Forward where the toe of the float turns up we have given the float a sharper rise to split the water easier in running when taking off and to reduce the impact forces in landing. The Navy in their latest float designs have given their floats as much as 40 deg. rise to counter the landing forces at this point. The writer has seen floats that were in service on the Vought Corsairs and the buckled plates forward gave mute testimony to the terrific

doped on each piece of leather having a cable hole in the center. Provide inspection holes as shown to inspect the lower elevator horn. The fuselage should now be given two coats of clear and two coats of pigmented wing dope.

The easiest method is to cut a piece of fabric large enough to cover the wing on both sides at once, then fold it over the trailing edge and tack it temporarily to the leading edge with 1/4 in. copper tacks. Tack it along the butt rib and sew it together around the wing tip. Gradually tighten the cloth by re-tacking and re-sewing to remove all wrinkles and fullnesses. The cloth should be stretched quite tightly from end to end along the leading edge. It is unnecessary to stretch the rest of the cloth extremely tight as the wing dope does that. Trim away excess cloth. Cut away the cloth in the aileron opening of the wing, leaving about 2 in. overlap. Tack the cloth to the aileron hinge beam on the wing and to the plywood web of the last common rib. Space the tacks 3 in. apart. Have the edges of the cloth overlap each other along the leading edge, around the aileron opening, and across the butt rib. Do a neat, smooth job. Now cut 7 ft. 6 in. lengths of 1/2 in. rib binding tape and wrap one length around the wing over each rib, tacking the ends down at the leading edge. Thread an 8 in. steel needle with linen rib cord and, starting at the trailing edge, push the needle clear through the wing, touching one side of a rib, and then bring it back through on the other side of the rib. The result will be a loop of cord clear

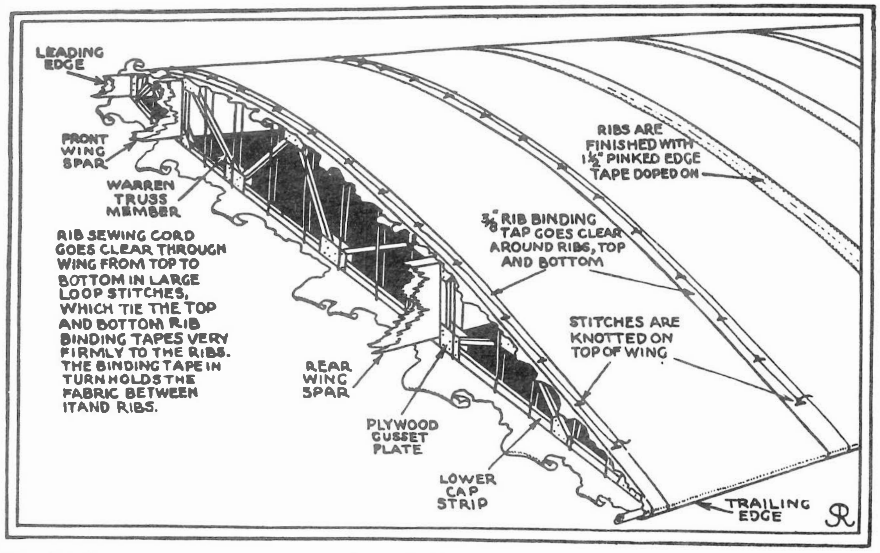


Fig. 24. In covering the wings of the Baby Bullet, a piece of linen large enough to go from trailing edge around the leading edge and back to the trailing edge again is stitched on as shown.

around the rib including and passing through both top and bottom binding tapes and the wing fabric beneath the tapes. Draw the loop snug and knot with a *square* knot on top of the rib. Sew forward in this fashion, looping and knotting at 4 in. intervals until the leading edge is reached, see Fig. 24. Now take 7 ft. 6 in. length of 1 1/2 in. pinked edged tape and wrap them on just as the binding tape was wrapped, with the ends overlapping at the leading edge. This tape must be heavily saturated with wing dope and stuck down with a brush to strengthen the sewing and to give the seams a finished, smooth appearance. Run a 2 in. pinked edged tape across the leading edge, around the wing tip across the trailing edge, as a reinforcement and to hide the rows of tacks and stitches. Cut out large strips of cloth to tape the butt rib and the faces of the aileron opening. The edges of these pieces should be frayed by removing a few ravelings from them, should overlap on the upper and lower surfaces of the wing about 1 in., and should be doped down neatly. The entire wing should now be given two coats of clear and two coats of pigmented wing dope. Do not use more dope than this, or the ribs may be distorted by tension. The ailerons are covered in the same way as the wings.

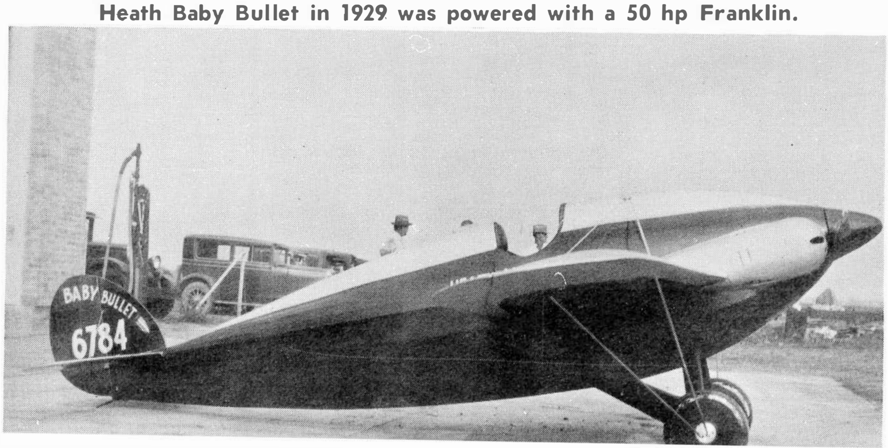
Covering the Empennage

The tail surfaces are covered in the same way as the wings. However, the leading edges, trailing edges, and hinge tubes must be wrapped to permit sewing the fabric to them.

Balancing the Raceplane

Note that in Fig. 17 the location of the vertical center of gravity of the plane is located at 26 3/4 percent of the chord from the leading edge. This is where it has to be if the ship is to fly well and be stable. Otherwise the plane will be unnecessarily dangerous. Make sure that this condition is fulfilled in this way: Make a light, stiff, wooden frame or cradle of 2 in. by 4 in. lumber to go under the fuselage and support the weight of the plane *only* at the strut points of the landing gear. Now balance the ship on this cradle on a wooden knife edge made of a 2 in. by 4 in. piece of wood on strong supports. It takes several men to perform this operation without injuring the airplane. Then your Bullet is ready to fly. • • •

Heath Baby Bullet in 1929 was powered with a 50 hp Franklin.



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with a small ball peen hammer. Do not rivet much, as it weakens the bolts. Just nick the bolts enough to hold the nuts. Cotter pins are preferred. Inspect with greatest care. Discard any hard wires that show any nicks, splits, or that have been bent more than once in a place. See that all wires are taut but *not* tight. See that control cables operate smoothly and drag nowhere. If they drag, try to remedy it, but in some places it may be necessary to install cable guides which can be obtained from aircraft supply houses. At this time determine just where each cable will pass through the fabric covering of the plane, and take measurements so that holes may be cut at proper places for the cables to pass through when the covering is on. Check everything for accuracy in every way possible. With the top longerons level the bottom of the wing ribs should be level, too, and the horizontal stabilizer of streamline section should be set with the center lines of its ribs level. It is possible to make the ship more stable at low speeds by giving the wing a 2 deg. angle of incidence, but this will slow up its top speed about 15 mph. With the control stick exactly vertical, the ailerons should be continuations of the wing in front of them and the elevators should continue the streamline section of the stabilizer in front of them.

Give all metal parts three coats of high grade black auto enamel, and finish the woodwork with two coats of shellac and two coats of fine spar varnish. The control cables should be heavily greased with clear grease.

Covering the Fuselage

In covering the plane use only best Grade A airplane fabric. Wrap the longerons tightly from end to end with 1 in. binding tape. The method of wrapping should be the same as for a spiral bandage. Fasten the ends with a little wing dope brushed on. Wrap the stern post. Cut a panel of fabric to fit the bottom of the fuselage, with about ¾ in. overlap all around the edges. Sew it with heavy linen rib cord to the binding tape on the longerons and stern post, and tack to the small, front bottom fairing with ¼ in. copper tacks at B, see Fig. 2, Part I, of this article. The fabric sides of the fuselage are applied in the same manner. The fabric should be stretched snugly by hand while applying. It requires four strips of fabric to cover the turtleback fairing. Tack these strips to the nailer strips provided, letting them overlap each other about ⅝ in., and sew, also, to the top longeron wrappings. When this is done, tape all the seams with 2 in. pinked edged finishing tape saturated with wing dope and brushed out smoothly at the edges. Now make the control cable outlet holes in the fuselage and reinforce each hole with heavy imitation leather

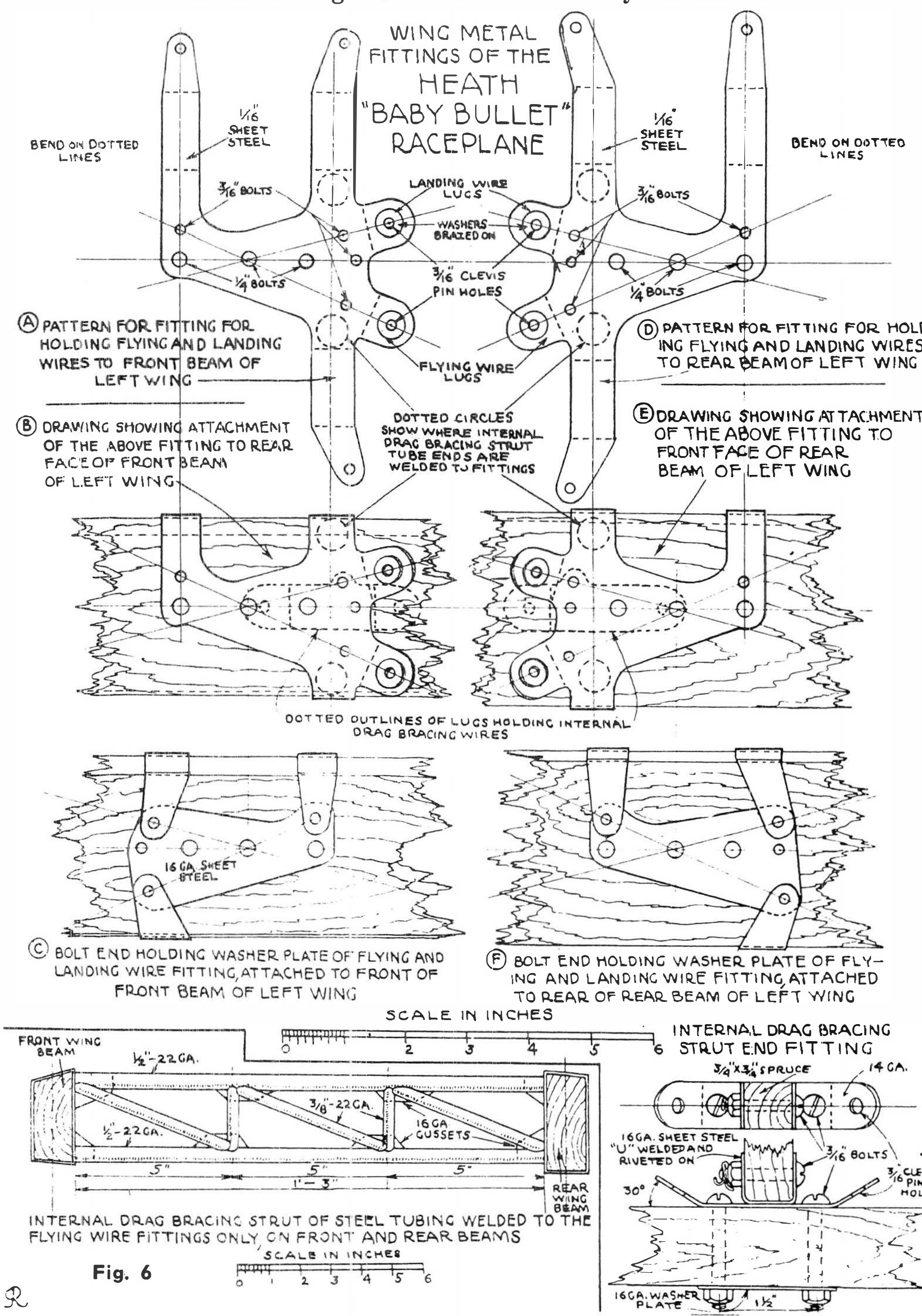
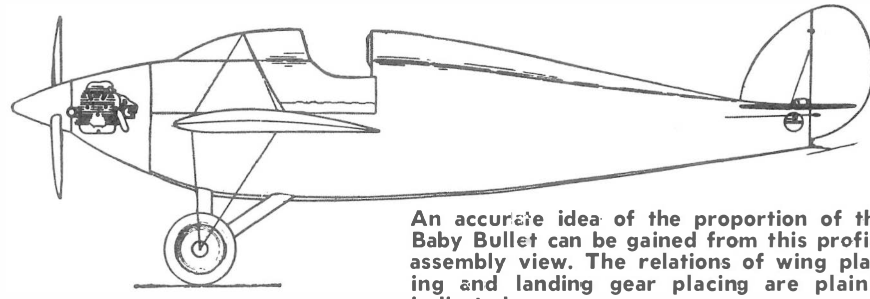


Fig. 6

The fittings for holding the flying and landing wires must be built with extreme care, as they absorb all of the stresses of flying and landing. The internal drag strut bracing, of welded construction, is shown in relation to the spar cross-section at the point of installation.



An accurate idea of the proportion of the Baby Bullet can be gained from this profile assembly view. The relations of wing placing and landing gear placing are plainly indicated.

sheet steel, welded to their hinge tubes and together at their tips. Their edges are flanged for stiffness, as shown in Fig. 22. The rudder control horn, being in the air stream, must be streamlined with balsa wood and fabric. The ribs are made with 3/16 in. 20 ga. steel tube cap strips. The leading edges are ¼ in. 18 ga. steel tubes, while the trailing edges are of 3/16 in. solid steel rod. Internal diagonal bracing, as shown, is accomplished with ¼ in. 20 ga. steel tubes. In Fig. 22, AA' detail of the horizontal stabilizer-elevators assembly shows the typical rib section of these surfaces. It is a streamline wing section set at 0 deg. incidence — that is, its center line is parallel to the top longeron. Note that instead of welding the cap strips of a rib to the leading or trailing edge at the same point, the strips are slightly separated and welded on side by side. At the trailing edge it will be necessary to flatten the tubes slightly for several inches to maintain the rib section. ⅝ in. 18 ga. lugs must be welded to the hinge tubes of the horizontal and vertical stabilizers to receive the ends of the 8-32 streamline tie-rods which brace the empennage. The hinges are made of ⅝ in. 18 ga. steel straps wrapped around the hinge tubes of the rudder and elevators and held to the hinge tubes of horizontal and vertical stabilizers by single 3/16 in. bolts passed through the tubes and straps, as shown in Fig. 22. Wherever a bolt passes through a tube, the hole must be reinforced by a piece of 16 ga. tubing inserted in the hole and welded in place, forming a "boss", see detail in Fig. 22. Small clips of ⅝ in. 18 ga. sheet steel are welded to the leading edge of the horizontal stabilizer as shown, to be held to angle brackets on the fuselage by 3/16 in. bolts. The hinge tube of the same stabilizer is held to the fuselage by two 3/16 in. bolts attaching it to clips on the fuselage near the stern post. The vertical fins' attachment to the fuselage is accomplished in this way: its hinge tube is telescoped into the stern post several inches, until stopped by a large washer welded to it, see Fig. 22; its front end is attached both to the small continuation of the fuselage turtleback built integral with the horizontal stabilizer and to the clip welded on the leading edge tube of the horizontal stabilizer by a 3/16 in. bolt welded in the lower end of the fin's leading edge tubing. Note that the lowest rib of the fin is shaped to fit the small turtleback and to have an inspection opening for the top horn of the elevators.

Control cables are of ⅛ in. extra flexible control cable. The right rudder control cable leads from the right horn of the rudder to the right end of the rudder bar. The elevator cables, however, are a different matter. The cable that leaves the rear of the torque tube goes to the top elevator horn, while the cable attached to the rear lug of the control stick goes to the bottom elevator horn.

Assembling

It is good practice to set the ship up complete before covering to make sure that everything is as near perfect as possible. Lock all nuts on with cotter pins, or by a slight riveting on the end

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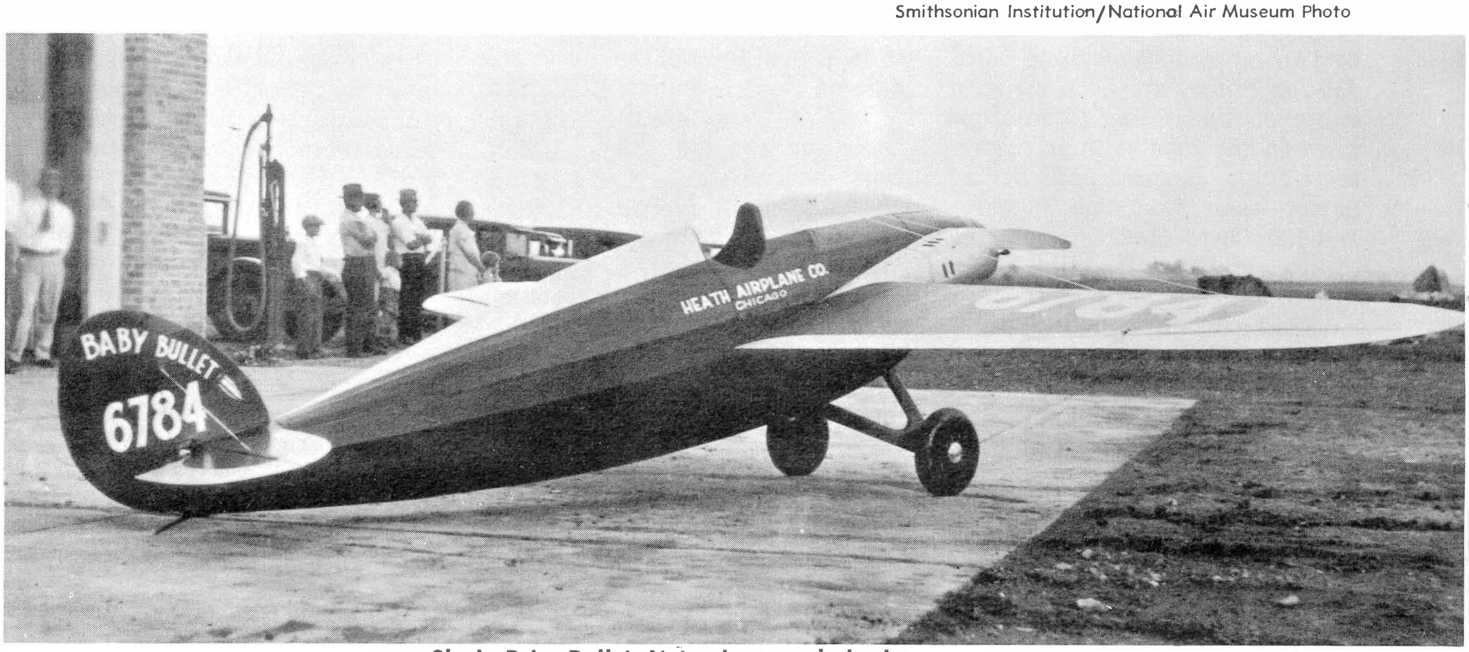

Sleek Baby Bullet. Note clean cowl cheeks.

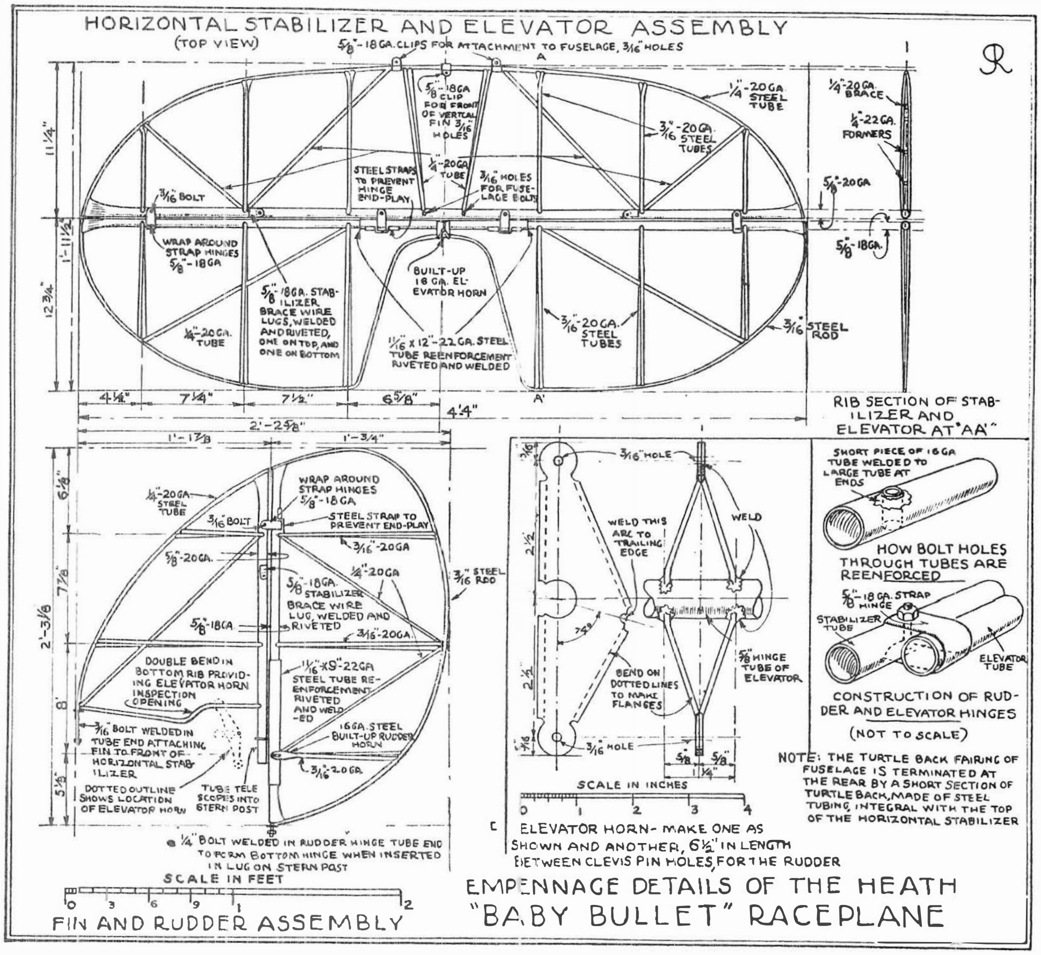

Fig. 22
The details for the horizontal stabilizer, the method of covering and the details of the control horns, flipper clips and rudder assembly are made clear in this drawing. Note the use of 3/16 in., 20 ga. shelby steel tubing. Control horns are welded.

ga. steel horn body has a large double lug bent over at right angles at the front. This flat lug is attached as shown to the rear side of the aileron hinge beam by two 8-32 machine bolts. The horn body is attached to the 3/16 in. plywood web of the horn rib by two more 8-32 machine bolts. Aileron hinges are each made of two eyebolts passing at an angle through the tops of their respective hinge beams, and having having their eyes laid together and held by a clevis pin passing through both eyes, see Fig. 17. As the beams are very light, they have to be reinforced at the hinge points by one-inch thick plywood blocks screwed and glued to the beams. To prevent the eyebolts being drawn too far into their beams, large square washers are welded to them. A web of 1/8 in. plywood is applied to the inner end rib of the aileron and to the adjacent end of the common rib at the inner end of the aileron opening in the wing.

Internal Wood Bracing of Wings

3/8 in. by 3/8 in. wood braces are applied inside the wing as shown in Fig. 18. First, wooden blocks are nailed and glued to the members to be united by a brace, then the brace is nailed and glued both to blocks and the members to be joined together.

Aileron Control Pulleys & Cables

Two 1 3/4 in. aircraft control cable pulleys of the common type, having sheaves possessing an eye with an eyebolt attached, are attached, as shown in Fig. 18, one above the other, to the rear face of the rear beam in front of each aileron horn by passing the eyebolts through the beam, resulting in an entirely flexible mounting. The control cable used is 1/8 in. extra flexible control cable, with ends made as shown in Fig. 3, Part I, of this article.

Flying and Landing Wires

Flying and landing wires are 10-32 streamline tie rods which may be obtained from aircraft supply houses on short notice. Use the regular terminal clevis except at the crown plate of the cabane where the threaded ends are passed through the holes provided and castellated nuts run down to hold them.

Tail Surfaces

Fig. 21 will give a good idea of the external appearance of the empennage, or tail surfaces. Fig. 22 shows everything necessary to know to construct them. The entire empennage is welded up of steel tubing, and this work should go quickly. There is little difference between the horizontal stabilizer-elevators assembly and the vertical-fin-rudder assembly save size and position. The stabilizers have 5/8 in. 20 ga. steel tube hinge beams, while the elevators and rudder have 5/8 in. 18 ga. hinge beams reinforced, as shown, by telescoped pieces of 11/16 in. 22 ga. tubing at the horn positions. These reinforcements are welded and riveted in place. The control horns are simple two-piece affairs cut from

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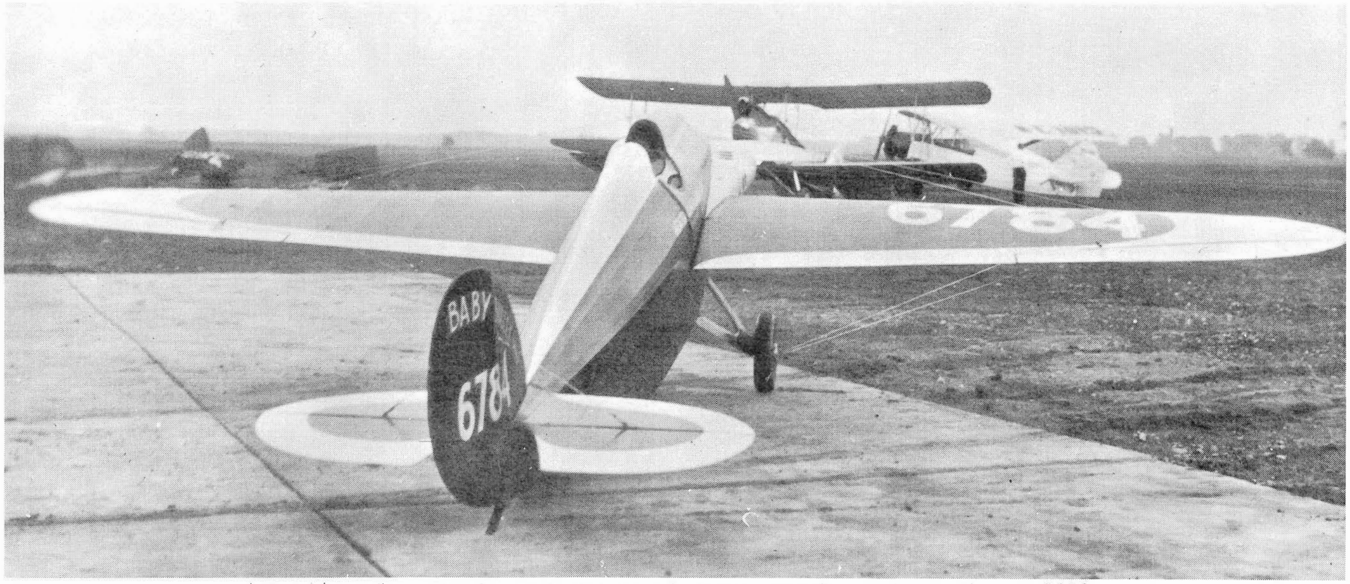


Not a modern Goodyear type racer but the amazing Baby Bullet of 1929.

Trailing Edges

Fig. 20, C, shows how the 1 in. 20 ga. "Vee" section aluminum trailing edge is applied to the rear tips of the ribs with 3/8 in. 21 ga. flathead nails. Fig. 20, A, illustrates how a 1/4 in. 18 ga. steel trailing edge tube is applied to the rear tips of the aileron ribs by means of 1/4 in. 20 ga. copper straps wrapped and soldered around the tube and fastened with 3/8 in. 21 ga. flathead nails to the rib ends. The rib ends must be notched slightly to hold the tube firmly.

Wing Tips

The leading edge is bent back slightly to meet the tip of the front wing beam, where it is attached with small screws and airplane glue. Then the flattened end of the curved 5/16 in. 18 ga. steel tube wing tip is screwed to both the leading edge strip and the end of the front wing beam to form a neat splice which is covered with a strap of 20 ga. copper, which is first soldered to the steel tube and then nailed to the front wing beam. This wing tip tube is fastened in a similar way, shown in Fig. 20, A, to the tips of the rear wing beam and aileron hinge beam of the wing.

Ailerons

The ailerons of the original "Baby-Bullet" were of the oblique type shown by dotted outlines in Fig. 18. This type of aileron is extremely difficult to build and to hinge. The ailerons used in the original were welded up of small steel tubing and were very successful. The straight-type aileron shown in the drawings by the author, Fig. 18, will be found, however, much easier to construct and entirely satisfactory.

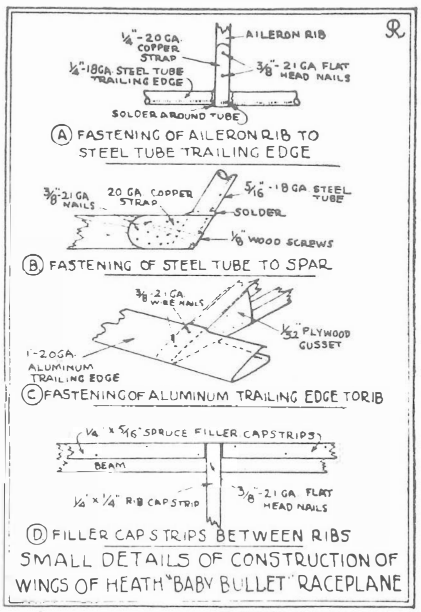


Fig. 20. These details show the method by which the trailing edge is covered with aluminum stripping.

At this period of the construction of the plane it is only necessary to saw between the aileron hinge beam on the wing and the hinge beam of the aileron to entirely separate the aileron structure from the wing structure. Apply 1/4 in. by 5/16 in. filler cap strips to the tops and bottoms of these beams, between ribs, to give an even edge, see Fig. 20, D. Brace the aileron internally with 3/8 in. by 3/8 in. spruce strips, as shown. Fig. 17 shows the construction of the aileron horn, which is made of 16 ga. sheet steel with 3/16 in. plywood applied to both sides and held by rivets passing clear through, as in a butcher knife handle. The 16

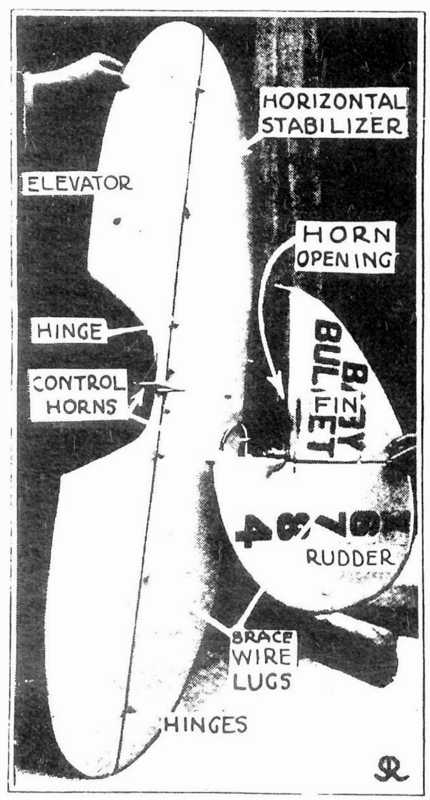
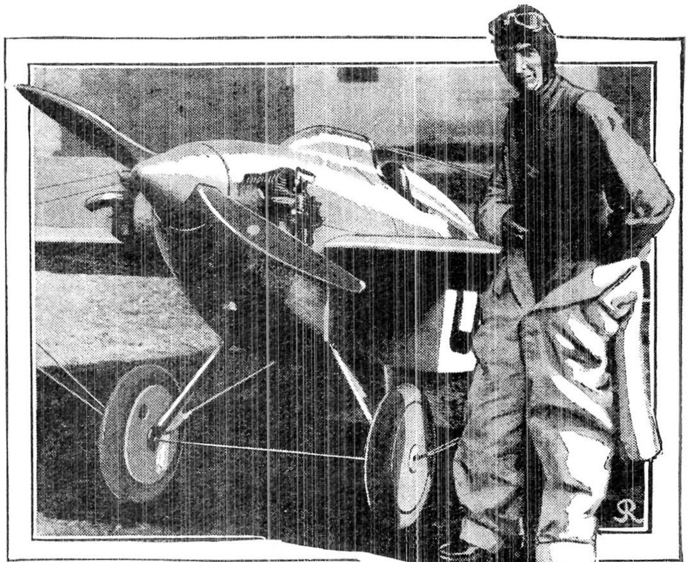


Fig. 21. A good idea of the component parts of the tail assembly can be gained from this photo. The horizontal stabilizer is barely waist high.



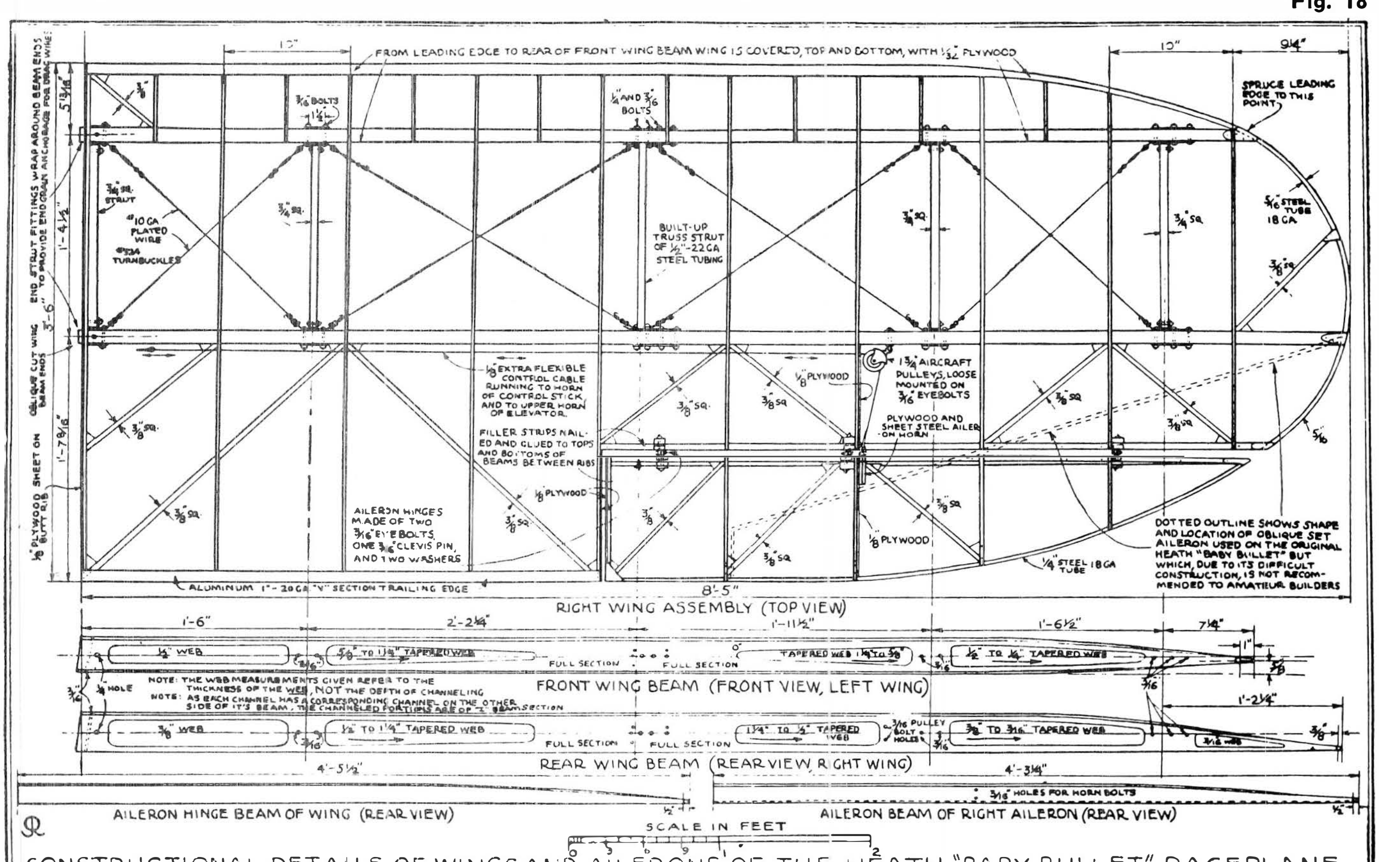
Here is Ed Heath, small of stature, alongside the Baby Bullet. Heath makes the midget racer look larger than it really is.

ga. plated aircraft wire, with No. 324 turnbuckles. The forks of the turnbuckles are secured with clevis pins to the lugs on the front wing beam metal fittings, and the other ends of these wires are attached by means of clevis to the rear wing beam's metal fittings' lugs. Note that the wing tip drag strut's end metal fittings are modified to hold three bolts, making a secure end anchorage for the internal drag wire bracing. The drag strut end metal fittings of the wing butt are modified to wrap around the wing beam ends into which they are recessed a little to make smooth wing beam ends bearing against the fuselage wing fittings. Thus a good end-grain anchorage for the drag bracing wires is obtained. These combination strut and wire anchorage fittings are each attached by a $\frac{1}{4}$ in. bolt passing through their respective wing beam ends, see Fig. 18.

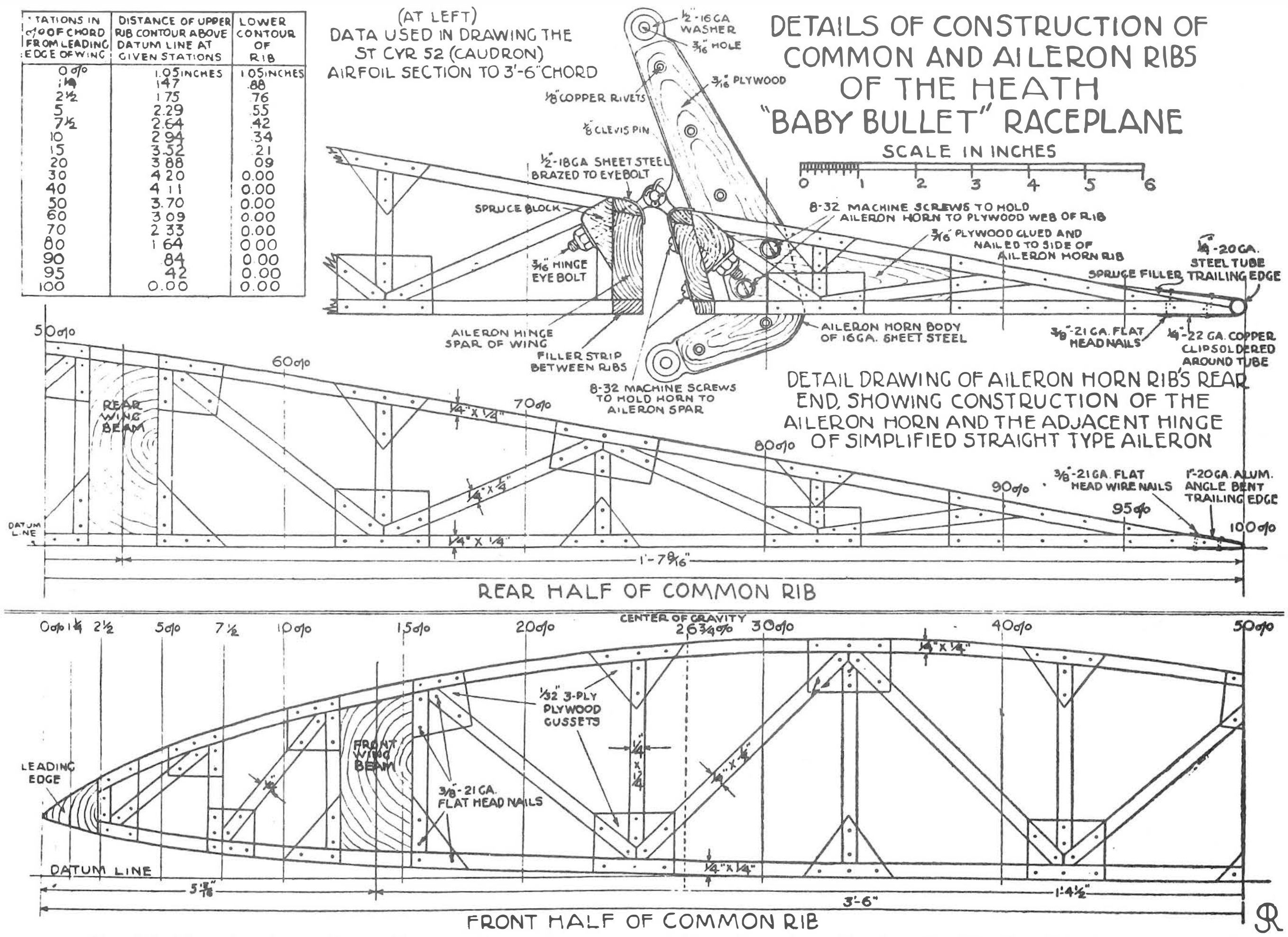
Leading Edge

Figs. 17 and 18 show the leading edge clearly. It is made from a long piece of 1 in. by 1 in. spruce attached with airplane glue and nails to each rib's front tip while in its square condition. Now install the $\frac{3}{8}$ in. by $\frac{3}{8}$ in. wooden brace strip shown in the upper left hand corner of the right wing, shown in Fig. 18, using small wooden blocks and plenty of nails and glue for end anchorage. With a small sharp plane carefully plane the leading edge to the cross section shown in Fig. 17. Now install the so-called false ribs which reach only to the rear of the front beam between the noses of the real ribs. Cover the front of the wing, top and bottom with 1/32 in. plywood back as far as the rear of the front beam. Use glue and $\frac{3}{8}$ in. 21 ga. flathead nails to hold the plywood in place. $\frac{1}{8}$ in. plywood must be applied with glue and $\frac{1}{2}$ in. 21 ga. flathead nails to the face of the butt rib of each wing.

Fig. 18



CONSTRUCTIONAL DETAILS OF WINGS AND AILERONS OF THE HEATH "BABY BULLET" RACEPLANE



STATIONS IN % OF CHORD FROM LEADING EDGE OF WING	DISTANCE OF UPPER RIB CONTOUR ABOVE DATUM LINE AT GIVEN STATIONS	LOWER CONTOUR OF RIB
0 %	1.05 INCHES	1.05 INCHES
1¼	1.47	.88
2½	1.75	.76
5	2.29	.55
7½	2.64	.42
10	2.94	.34
15	3.52	.21
20	3.88	.09
30	4.20	0.00
40	4.11	0.00
50	3.70	0.00
60	3.09	0.00
70	2.33	0.00
80	1.64	0.00
90	.84	0.00
95	.42	0.00
100	0.00	0.00

Fig. 17. The simple method, thoroughly modern, of building the wing ribs for the St. Cyr 52 wing section of the Baby Bullet is here shown very clearly in full detail. Construction of the control horns is also made clear.

ers—everything must be rounded in the channels. Cut the fuselage ends of the beams, as shown to fit the angle of the beam fittings on the fuselage. Cut the wing tip ends of the beams according to the drawings. Now drill the bolt holes in this manner: drill slowly through until the tip of the bit just shows on the far side; then drill from the far side to complete a smooth hole with no splintered edges.

The original "Baby-Bullet" had built-up three-piece wing beams, with solid flanges and plywood sides, but as the "I" beam solid beam is easier to construct and thoroughly reliable, it is described in this article. The Department of Commerce frowns somewhat upon homebuilt, built-up wing beams.

The aileron hinge beams of the wings and of the ailerons are made according to Figs. 17 and 18, and are not much different from wing beams excepting that they are smaller and not channeled, but left of full section.

At this point in the construction of the wings, the ribs should be slipped to their proper places on the wing beams and fastened in place with airplane glue and nails driven through the vertical strips, in front of and in rear of the beams, into the beams. The aileron beams should now be slipped through the aileron ribs and fastened in the same manner.

Note that the last two ribs of the wing tip are special ribs of shorter chord than common and regular aileron ribs. They must be drawn to the same wing section as the common ribs, only of shorter chord. This may be accomplished by reducing the measurements given in Fig. 17 by a simple arithmetical reduction. These tip ribs must be fitted with care that their angle of incidence is the same as that of the rest of the wing, namely 0 deg. To fit them properly will require some cutting and shimming of the wing beam tips.

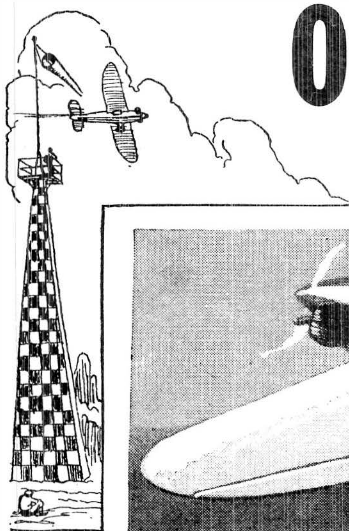
Metal Fittings of the Wings

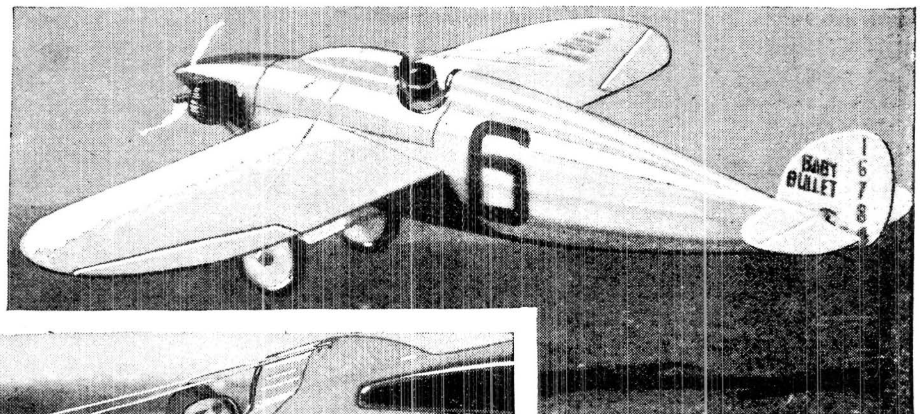
Fig. 19 illustrates the metal fittings of the wings and presents patterns for the flying and landing wire fittings of the beams. Make these anchor fittings with greatest care, for they are vital. Do not bend them more than once in a place. Make up two of the double, built-up, steel tube, drag bracing struts that connect these anchor fittings, and weld their ends to the fittings as shown. These steel struts and their fittings *must* be installed on the wing beams *before* the ribs are slid on.

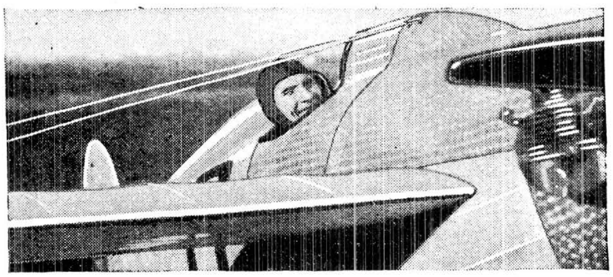
The ordinary ¾ in. by ¾ in. drag bracing struts can be installed after the ribs are installed. Their ends are held in conventional strap fittings, as shown in Figs. 18 and 19.

The internal drag and antidrag wire bracing is made of 10

BUILDING THE WINGS OF THE "BABY BULLET"







The "Babe" zooms off the ground like a pursuit ship and climbs 1,500 feet per minute. To the left is Ed Heath. These shots were taken at Mines Field, Los Angeles, at the recent air races.

Summing up the last of the details of the building of the Baby-Bullet Racing Plane, Stewart Rouse gives pointers on the wing construction.

PART III

Consulting Fig. 17 you will see that the ribs are made of ¼ in. by ¼ in. spruce fastened together with airplane glue, and 1/32 in. plywood gusset plates, with ⅜ in. 21 ga. flathead nails driven through them and clinched. The drawing, Fig. 17, shows the rib drawn accurately to scale, but separated into two halves by the vertical line at the 50 percent point; this must be taken into consideration when drawing the wing section on a smooth one-inch board in pencil, using double lines to show the top and bottom curves, and the bracing pieces. Now glue and nail small blocks of wood along these outlines at two and three-inch intervals to hold the rib pieces securely in their relative positions, while nailing and gluing the gussets to one side; then turn the rib over on a flat surface and nail and glue the gussets of the reverse side. The jig must be modified to hold the slightly different aileron ribs.

The Wing Beams

Fig. 18 gives a clear conception of the top view of the right wing, and also of wing beams and aileron beams. Use the finest aircraft spruce for the beams, ordering it from a reliable aircraft supply house. Fig. 17 gives a clear impression of the full sections of the beams as maintained at strut points. At points between struts the beams are channeled carefully, as shown in Fig. 18, to produce an "I" beam section. This "I" beam cross section is by no means constant, because certain points along the beams receive large bending stresses, while other points receive little but compressive stresses, from end to end such as a column undergoes. Follow the beam drawings carefully and remember that it is better to *leave* on too much wood than too *little!* Don't be a lightweight fan at the risk of structural failure. In cutting the channels in the beams, work with gouges small enough that a mallet is not necessary, as pounding may split the beams ever so little, which is dangerous. Cut the beams with sharp tools, leaving no splinters and *no* sharp corn-

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Heath "Wee Mite" Baby Bullet. Weight 250 lbs., 14 ft. long, 18 ft. wing span.

phragm into place and weld it to the end of the stub axle all around, and to the front strut.

Weld the steel boss that the 5/16 in. spreader tie rod passes through to the small end of the flying wire lug, and the diaphragm, as shown, and then drill an oversize 5/16 in. hole through both bosses for the 5/16 in. spreader tie rod. Two wheel retaining end plates must now be turned from aluminum. They are held on by two ¼ in. machine screws screwed into threaded holes in small brackets welded inside the end of the stub axles, see Fig. 13. The wheel hubs are made from 12 ga. steel tubing with turned bronze bushings in each end which have integral flanges, which serve as spoke hole flanges. This is a reliable type of hub and is sometimes used in full-size ships.

The Motor Mounting

In the original "Baby-Bullet" the motor mounting, see Fig 14, was made integral with the fuselage and had the usual disadvantages of such an arrangement, and furthermore it did not develop the full strength of the material used in its construction. An improved motor mounting similar to that now used in the 32 hp Bristol "Cherub" motored "Super-Parasol" Sportplane is shown in Fig. 15. As indicated, it is made entirely of ⅝ in. 18 ga. steel tubing reinforced heavily and flattened at the ends. The bracing is accomplished with 10-32 aircraft tie rods. If the "Heath Henderson" or the new Heath "Bee 4" 40 hp motor is used instead of a Bristol "Cherub", a modified "Super-Parasol" type, "Heath Henderson" motor mount may be used, see plans of the "Super-Parasol." It is best to leave the motor mounting and motor cowling until the very last, as the only practical method of gaining perfect balance fore-and-aft is to move the motor itself an inch or so forward or backward as found necessary.

The Tanks

Unless one is quite experienced in tank making, it is best to have a tank maker construct the gasoline and oil tanks. Part I gives a good view of the installation of the 3 gal. gasoline tank on the top longerons under the cabane, and Fig. 14 gives a good view of the two quart oil tank mounted on top of the motor mounting. 20. ga. sheet steel is all right for these tanks. The gasoline tanks should have two transverse baffle plates. Note that the gasoline filler neck protrudes through the top of the instrument board. A sight gasoline gauge may be installed in the filler neck. It would be wise to install a reliable airplane gasoline filter in the gasoline line and a shut-off cock, with a long handle in reach of the pilot, should be installed beneath the tank for emergency use. The tanks must be insulated from their supports with heavy felt pads to absorb vibration which might cause damage.

The Propeller

The propeller used when racing the "Baby-Bullet" was 4 ft. 4 in. in diameter with 3 ft. 6 in. pitch, of walnut, and Heath-built. This, the "Cherub" motor turned at 2800 rpm on the ground.

The Cowling

Cowling can enhance a plane's beauty if rightly made, or hurt its appearance terribly if carelessly shaped. Fig. 8 and Fig. 16 show the cowling used on the "Baby-Bullet" pretty clearly. The propeller has a built up, large wooden hub, covered with the lower half of an 18 ga. spun aluminum cone, while the upper half of the same cone is attached in front by a row of small wood screws driven into the front edge of the big hub. The motor cowling has top and bottom halves, fastened together by 16 ga. steel hood fasteners which operate like automobile hood fasteners. The bottom half is made of two pieces riveted to an inside strap of aluminum with their edges just touching.

The double line of rivets runs fore-and-aft on the bottom center line of the nose. The sections of the motor cowling must be beaten into the shape shown by shaping 18 ga. soft aluminum sheet over a small leather pillow stuffed with lead shot, using a round faced wooden mallet for beating.

After beating for a short time, the aluminum will become hard and must be softened before further beating by heating it with a blow torch and plunging it in cold water.

If beaten hard, the aluminum will crack. When the motor cowling has been shaped, it is well to shape the pointed front part of the head streamline fairing, which must be riveted in place, as shown, on the stationary top cowling. The front of the motor cowling is supported by a large flanged aluminum disc attached to the front of the engine's crankcase while the rear is supported by the front bulkheads of the side and bottom fairing, and the bulkheads formed by the extension of the top of the firewall.

Note that the air intake of the carburetor must protrude through a hole in the bottom half of the engine cowling. •••

holes in the end plate.

Fig. 12 is a closeup of the left hand wheel with the stub axle end plate removed to show the interior of the left stub axle, the location of the end of the front strut of the landing gear, the end of the 5/16 in. spreader tie rod, and the double lug welded to the floor of the stub axle which takes the clevis of the left hand wing's flying wires. Fig. 13 is a closeup of the left hand stub axle with the wheel removed. In this note the interior of the wheel hub showing the turned bushings which are integral with the hub flanges which are drilled for the wheel spoke ends.

These photos give an excellent idea of the landing gear and its details, but turn to the drawing, Fig. 11, for the niceties of detail. The left hand vee of the landing gear it will be seen has struts of 7/8 in. 16 ga. steel tubing. Both front and rear struts are reinforced at their upper ends in the usual way, flattened, slotted, and drilled with ¼ in. holes to receive their respective lug fittings on the fuselage. The lower end of the front strut has an outside reinforcement in the shape of a 1 in. by 6¼ ft. 16 ga. tube, slightly reamed, slipped over it and fastened with ⅛ in. rivets passed clear through both tubes. Its lower end is cut at the angle shown in Fig. 11, and its length from the center of the bolt hole in its upper end to its extreme lower end is 1 ft. 5 in. The lower end of the rear strut is later welded to the back of the lower end of the front strut, as close to the 12 ga. steel stub axle diaphragm as possible.

It has a 4 in. inside reinforcing tube at its lower end held in place by four ⅛ in. rivets. Its length from the center of the bolt hole in its upper end to its extreme lower end is approximately 1 ft. 9¾". These landing gear struts have streamline section fairings, as shown, of balsa wood taped on with a neat wrapping of 2 in. tape and five coats of wing dope. This fairing, however, should not be applied until the landing gear is otherwise complete. Now make the flying wire end lugs shown in Fig. 11, one right and one left hand. Next make the two 12 ga. circular diaphragms that must be welded to the inner ends of the stub axles. It takes clever welding to put one of these stub axles together. Slip the diaphragm up on the front strut for about one foot to have it out of the way. Weld the flying wire lug to the front strut end as shown. Weld the steel boss that the nut of the 5/16 in. spreader tie rod seats against in place. Now weld the flying wire end lug to the floor of the stub axle, which is made of a length of 3 in. 14 ga. steel tubing. Now slip the dia-

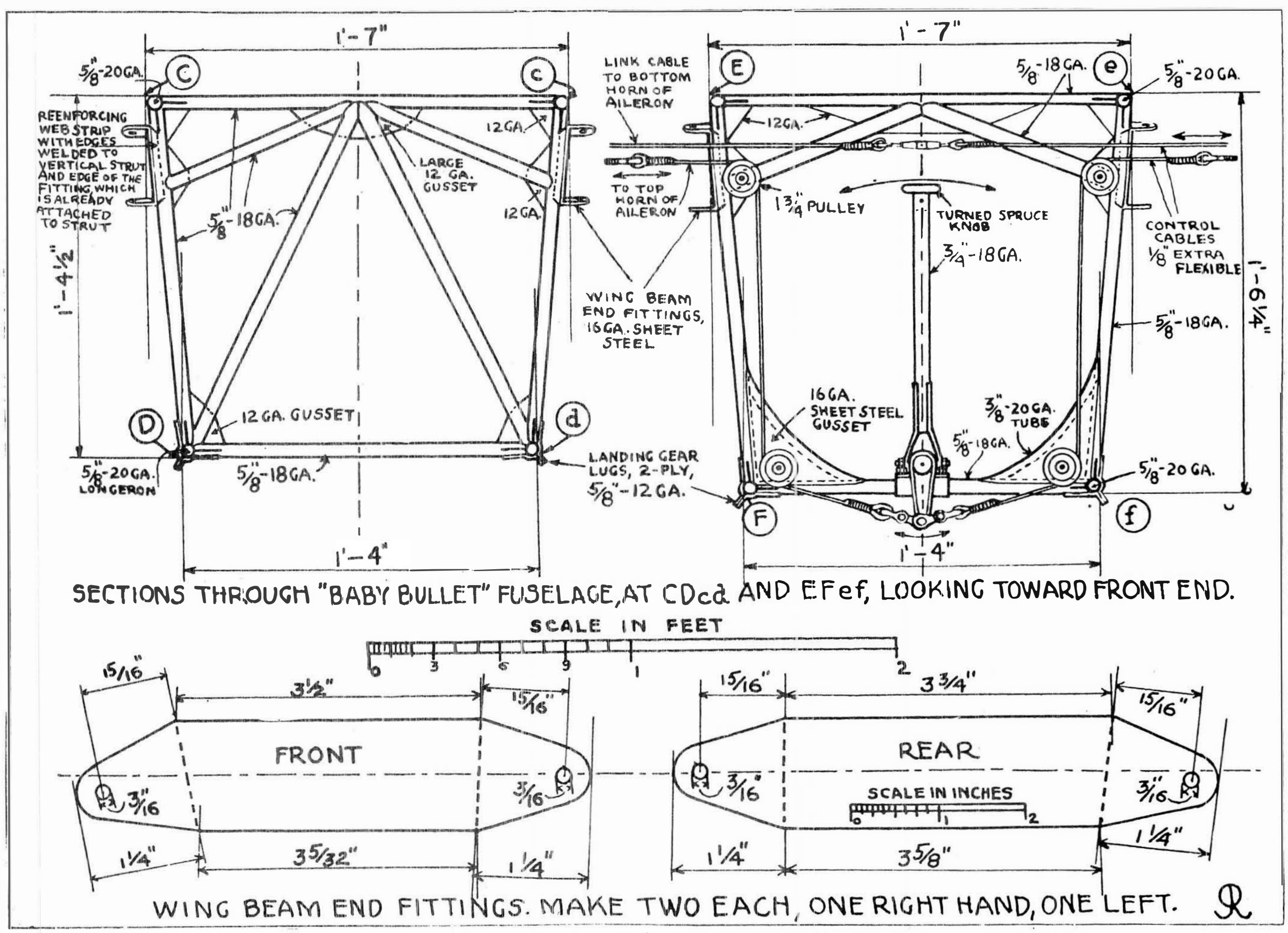


Fig. 4. The improved method of constructing the cross bays of the fuselage as described by Mr. Rouse are here shown in full detail and depicts the new bracing which has been lately adopted.

fuselage joints at the ends of horizontal strut "H" with triangular hard wire loops fastened to the longeron fittings with clevis in the conventional manner.

Heel plates of 18 ga. half hard sheet aluminum fastened by the same means as the seat bottom run from "B" to "F" on each side of the torque tube, forming a sort of skeleton floor.

The Fire Wall

The fire wall is made of a piece of 18 ga. aluminum fastened to the vertical struts at "AB" and the horizontal strut at "B." It is fastened to horizontal strut "A" with several clip fittings. Its upper portion extends above horizontal strut "A" and is cut to form a bulkhead to support the top and motor cowls. The edge of this bulkhead has a ½ in. flange.

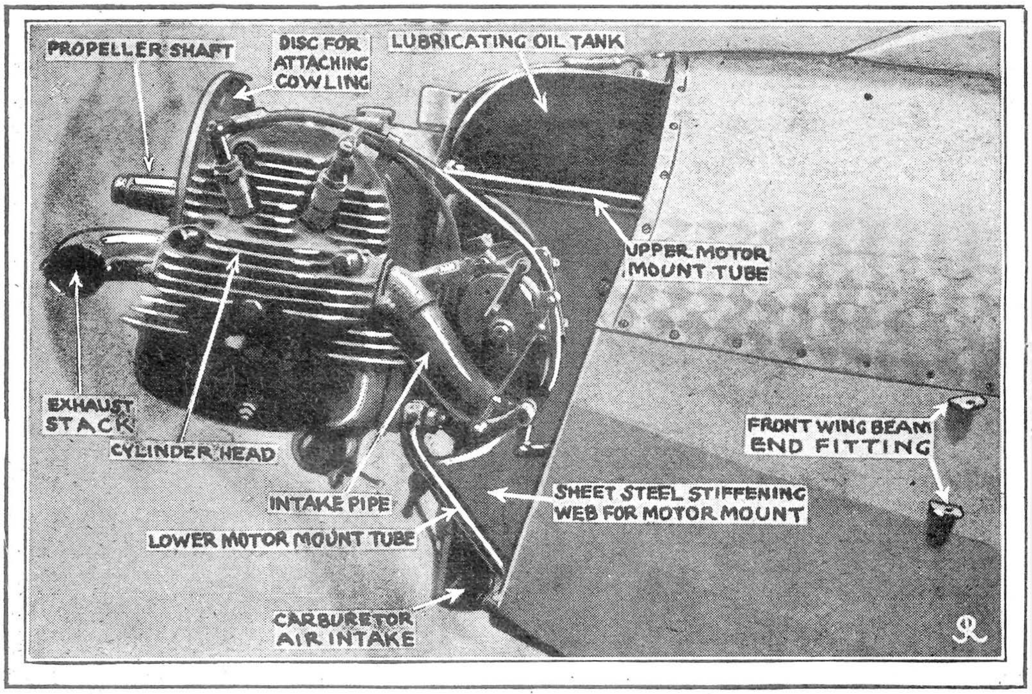


Fig. 14. The sturdy two-cylinder opposed Cherub motor.

The Fairing

The turtleback fairing consists of five transverse bulkheads, and at its large end 14 longitudinal stringers and 8 longitudinal nailer strips for tacking on the fabric cover. Fig. 9 shows patterns for the five bulkheads and a drawing of the "I" bulkhead which is typical. These bulkheads must be carefully drawn up as shown on 3/16 in. plywood, and then cut out with a scroll saw leaving large holes, as indicated, for lightness. Part I gives a good conception of the complete turtleback fairing. Notches are cut at appropriate points in the outlines for reception of the nailers and stringers which are glued and nailed in them. To attach the complete turtleback to the top of the fuselage, either small sheet steel clips attaching the bulkheads to the horizontal struts, or wrappings of linen rib cord saturated with wing dope applied as shown in Fig. 9 may be used. The best way to build the turtleback is to attach the bulkheads in their places on the fuselage and then attach the nailers and stringers. A head pad made of curled hair and automobile upholstering material is applied to the front of the front bulkhead after the turtleback has been covered with fabric.

The bottom fairing is made in the same way as the turtleback. However, it is very shallow. Its patterns are given in Fig. 9.

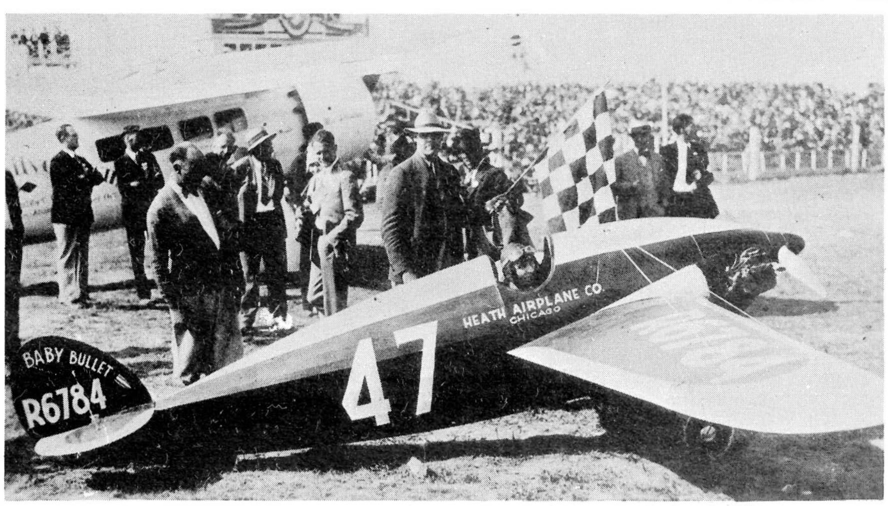
The side fairing only requires one shallow nailer bulkhead at "AB." It is of 3/16 in. plywood. Its notches carry the two side fairing strips, the upper of which is ¼ in. by ⅜ in. and the lower ¼ in. by ½ in. They are attached to the vertical struts by wrappings of linen rib cord saturated with wing dope as shown in Fig. 9. These side fairing strips run the entire length of the fuselage.

The Landing Gear

The landing gear is at once the heart of this little ship and the hardest part to build. It must be built *well,* for the greatest strains both in flying and landing center in it in this ship.

Fig. 10 shows its appearance and general layout. The wheels, as shown, are cloth covered, to reduce air resistance, and both 14 in. by 3 in. and 18 in. by 3 in. rims have been used, with special hubs which will be presently described. Fig. 10 clearly shows the 5/16 in. 24 streamline spreader wire of the landing gear and the wheel retaining end plate of the left hand stub axle, with the ends of the clevis of the 10-32 streamline flying wires seen protruding slightly through their

Bob Whittier Photo

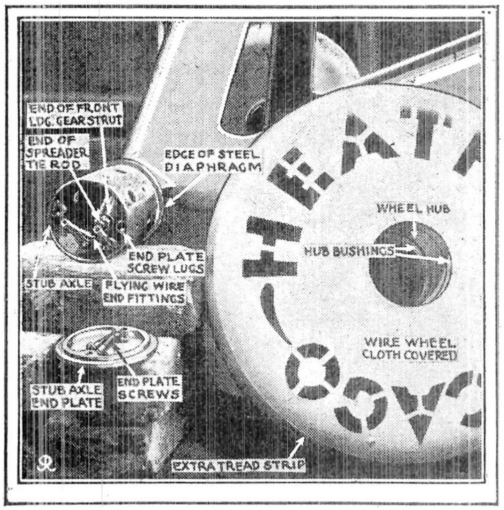


Heath's Baby Bullet beat everything in its class at the National Air Races.

clip ends and tripod leg ends. The clips are secured against slippage by rivets passed through clip and strut. *Wherever* a tube is flattened, reinforce it by telescoping a smaller tube inside it at the point to be flattened, and flatten *only* while *red* hot. Note that when the pilot's *right* foot is pushed *forward* the plane turns to the *right* and vice versa, which is exactly opposite the result obtained with a sled's foot bar.

The Instruments

The instrument board is made in this way. A piece of 3/32 in. plywood is cut to the exact size and shape of the completed instrument board. This is to be the face. Holes are next cut in it of



correct size and in position for the insertion of the instruments and incidentals. Lay this piece upon a piece of 3/16 in. plywood and with a sharp pencil draw its outline and the outlines of the instrument holes upon the 3/16 in. piece. Draw a line around the 3/16 in. piece about ¾ in. from the edge, and a line around the outline of each instrument hole cutting about ½ in. from the outline. Now draw in double lines about ¾ in. apart connecting the instrument holes with each other and to the ¾ in. outline space. Cut the pattern thus obtained on the 3/16 in. piece of plywood with a scroll saw.

It should have an appearance when completed somewhat similar to that of the turtleback fairing bulkhead shown in Fig. 9, the main difference being the presence of several plywood rings for instruments to be installed in. This 3/16 in. piece must now be matched up with the reverse side of the 3/32 in. face piece and glued in place with airplane glue. The finished instrument board will thus be well reinforced around the edge and edges of the instrument holes. For a nice finish, sandpaper it, stain as desired, apply two coats of shellac and one coat of spar varnish. The instrument board is attached to the top longerons and rear cabane struts with small steel clip fittings. The magneto switch is installed on the left side of the panel, the choke handle at the bottom center, the tachometer at the center, while the oil pressure gauge is at the right. Incidentals on the instrument board are the gasoline filler neck at the top of the panel and the lap counter just above the oil gauge. This last is a strip of 18 ga. soft sheet aluminum about 1½ in. by 5 in. mounted crosswise on the panel (see photo, last part). It has nine saw cuts to make ten ½ in. by ¾ in. vertical tongues. After completing the first lap of the race the pilot bends the first tongue toward him, and so on until all ten laps are run. The idea being to prevent mistakes in counting laps on the part of the pilot in the excitement of competition.

The hand throttle of the carburetor is installed on the left top longeron 5 in. ahead of the instrument board. It is of conventional design and can be made or purchased cheaply from the designer.

The Seat

The seat bottom is made of a piece of 18 ga. half hard sheet aluminum wrapped around the bottom longerons and horizontal strut "F." After being wrapped around the tubes it is bolted back to itself, as shown, with ⅛ in. bolts. Its front edge is rolled over like the edge of a bucket to prevent cracking. The seat back is made of a piece of 20 ga. half hard aluminum sheet. It is fastened to horizontal struts "G" and "H" by having its ends rolled over them and fastened back to itself with ⅛ in. bolts. Its edges are rolled over to prevent cracking; see Part I. In the center of the front edge of the seat will be seen a half conical guard, the purpose of which is to keep the greasy elevator control cables from rubbing the pilot's trousers. It is riveted on.

The safety belt is a standard 2½ in. web belt, fastened to the

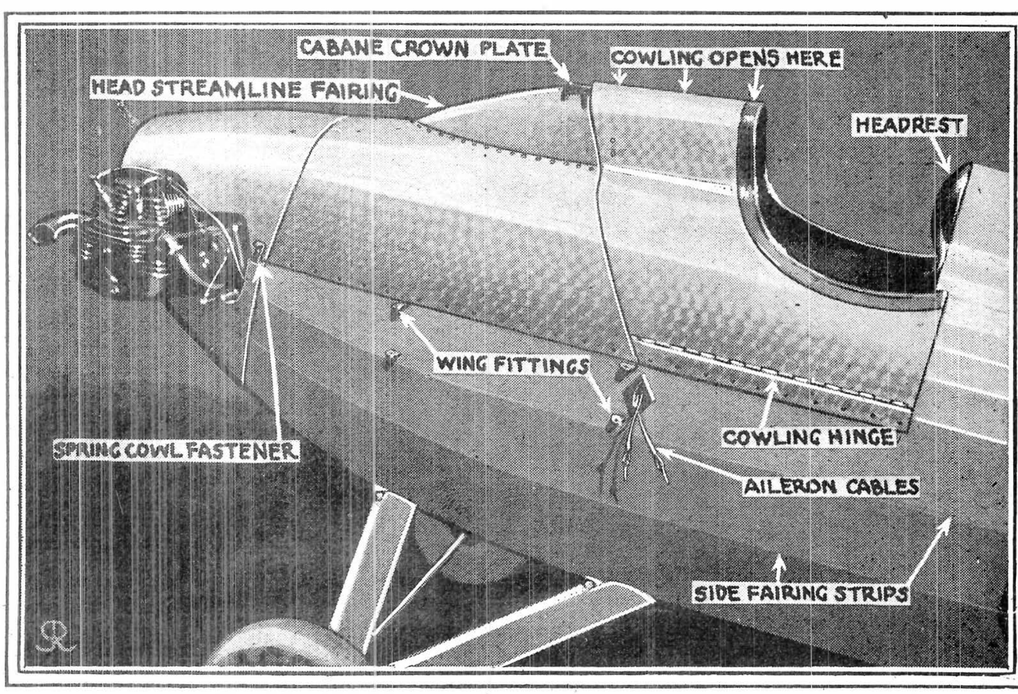


Fig. 16. Cowling details of the Baby Bullet.

shown in Fig. 7 of this installment, while the other, a flat piece, is welded to its front edges as a stiffener, and to the rear face of this stiffener's lower end is welded a 1/8 in. by 5/8 in. washer, with a 3/16 in. hole drilled through it, and the stiffening piece, to provide attachment for the aileron control cable fitting.

The original "Baby-Bullet" was equipped with rudder pedals or stirrups as shown in Part I. This worked well enough, but the common rudder bar, as used so successfully in most of the "Super-Parasols" and shown in Fig. 7 of this installment, will prove easy to make and highly satisfactory. As shown, it consists of a foot bar pivoted at the center, in the same manner as the foot bar of a steerable sled, with the rudder cables attached to its ends and actuated by the movements of the bar produced by the pilot's feet. As these cables are also attached to the horns of the rudder, they communicate the movements of the rudder bar directly to the rudder, producing changes in direction of flight.

The rudder bar consists of a piece of 5/8 in. 18 ga. steel tubing reinforced, slotted and flattened horizontally at the ends, and drilled to receive 3/16 in. bolts which hold short steel straps, to which are attached the 324 turnbuckles of the rudder cables. At its center the rudder bar is reinforced at top and bottom by means of 1/16 in. by 1 in. washers welded on to form a better bearing for the 1/4 in. bolt which attaches it to the 14 ga. steel crown plate of a tripod of 1/2 in. 20 ga. steel tubes, each of which tubes is reinforced and flattened at the ends. The legs of this tripod are attached to the crown plate by riveting and welding, and to the horizontal bottom struts of the fuselage "B" and "D" by means of 20 ga. steel clips wrapped around the struts and clamped on the flattened ends of the tripod legs by 3/16 in. bolts passing through both

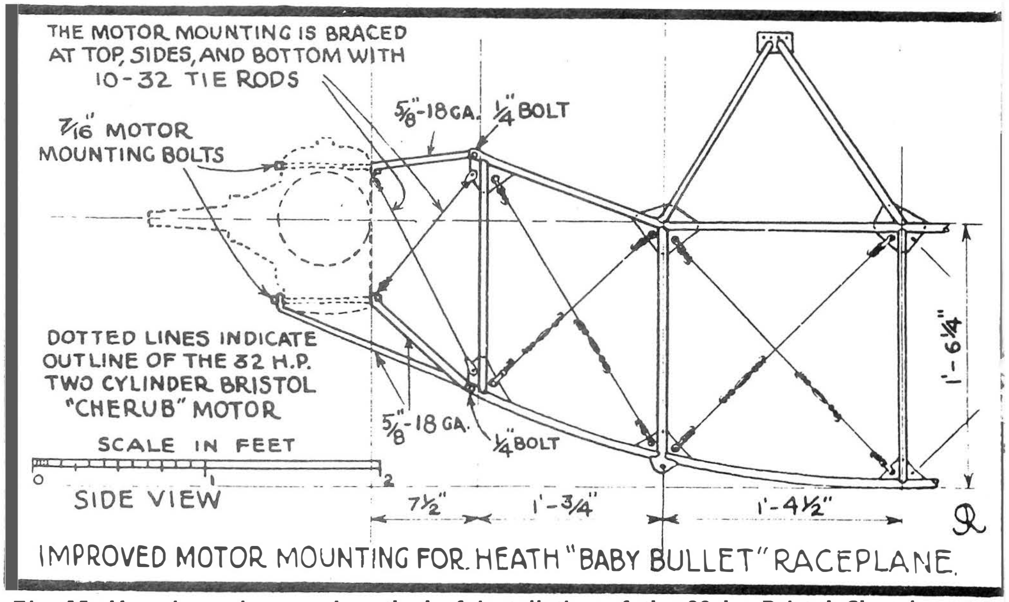
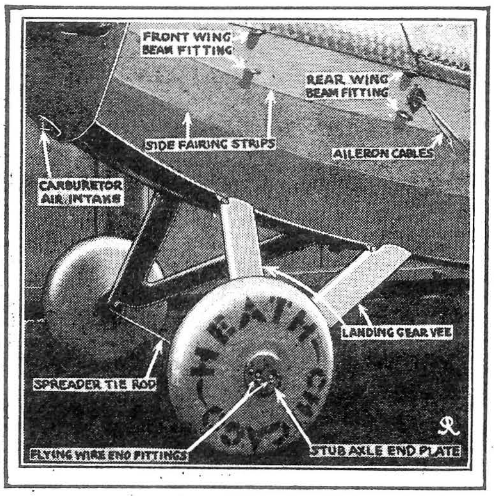


Fig. 15. Here is an improved method of installation of the 32 hp Bristol Cherub motor.



Left—Fig. 10. Landing gear of the Baby Bullet, with adjacent fuselage details. Center—Fig. 12. Closeup of the left wheel with stub axle end plate removed to show details. Right—Fig. 13. Left stub axle with wheel removed to show parts.

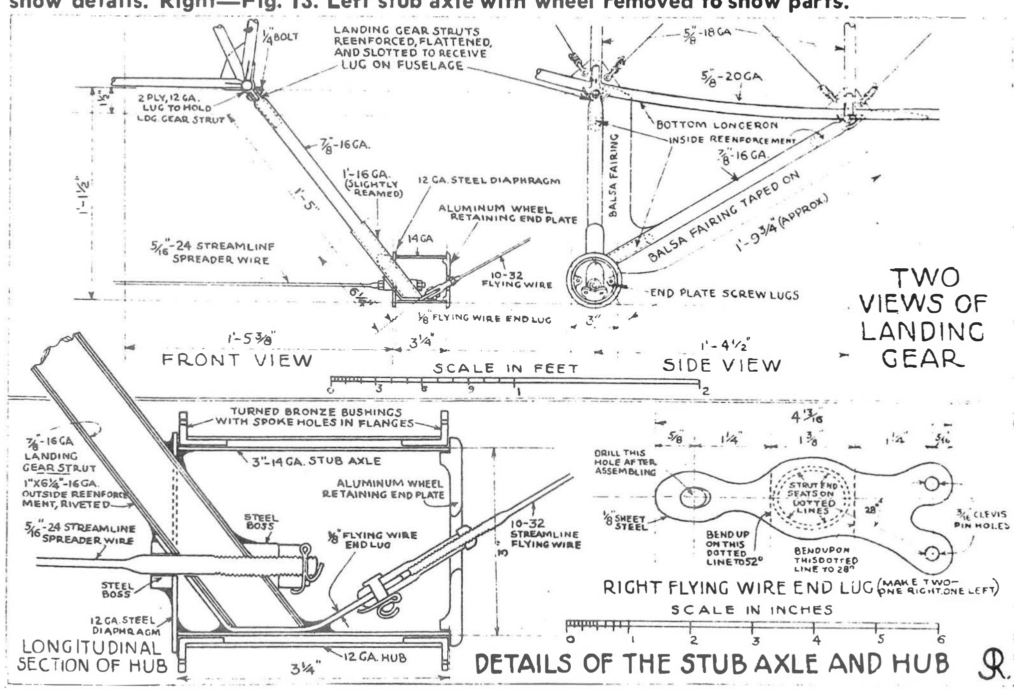


Fig. 11. Drawing showing structural details of the landing gear and cross tie rod axle.

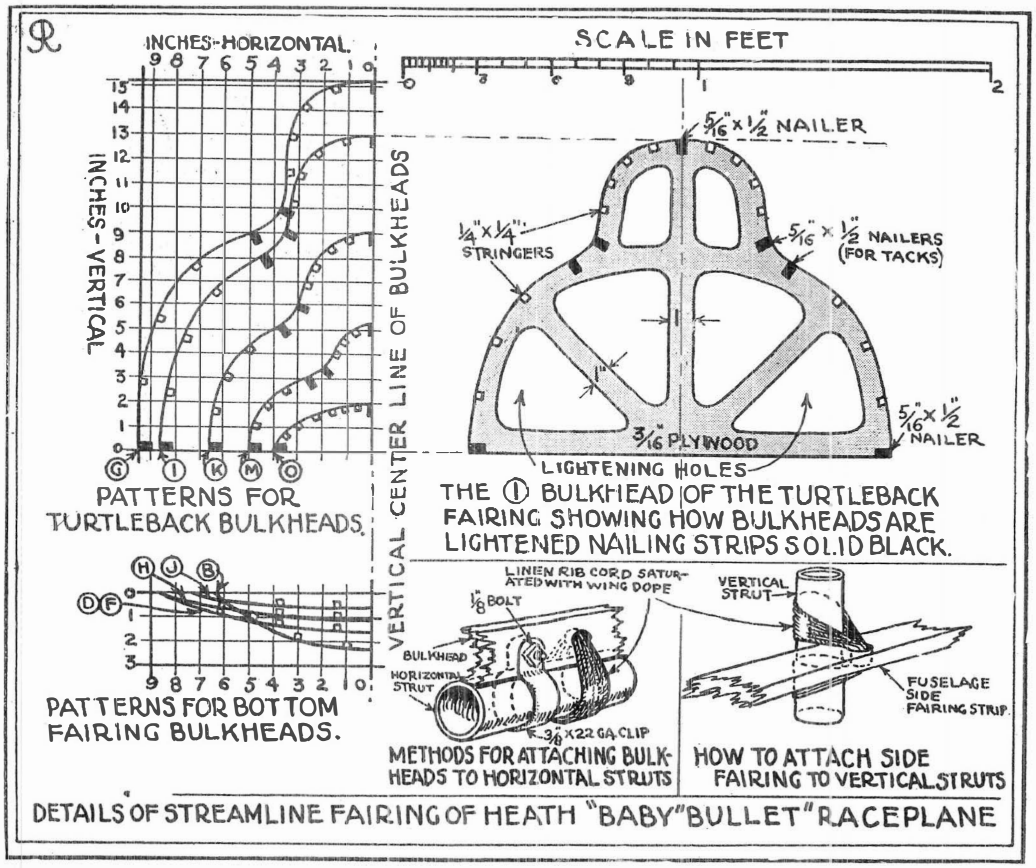


Fig. 9. These details of the streamline fairing of the Baby Bullet give an accurate gauge to follow in constructing this important item. Note how the strut is lashed.

direction, as shown, and in order to prevent undue fore-and-aft movement, due to the pull of the elevator cables, it will be necessary to place collars of steel tubing, held by rivets as shown, upon it to act as thrust bearings against the end bearings.

With its pin 4½ in. forward of the control stick taper pin a 1¾ in. aircraft control cable pulley is let into a slot in the top of the torque tube where it is supported, as shown in Fig. 7, by a ½ in. 16 ga. steel strap bent around the torque tube and brazed or welded in place, so that its drilled upper ends hold the pulley by means of a 3/16 in. bolt passing through them and the pulley.

The control stick has an 18 ga. steel double-ended control cable lug passing clear through it from front to back, and welded in place with its clevis pin holes 3 in. above the center of the taper pin of the torque tube.

The control cable for the bottom horn of the elevators is attached by means of a cable end, shown in Fig. 3, Part I, to the eye of a 324 turnbuckle, which in turn is fastened by its forked end and a clevis pin to the rear control cable lug of the control stick. The control cable for the top horn of the elevators is fastened by a cable end and clevis to the front lug of the control stick, from whence it passes forward over the torque tube pulley and back inside the torque tube, and thence back through the fuselage to the top horn of the elevators.

At the extreme rear end of the torque tube the downward pointing aileron control horn will be noted. Control cables run to right and left from the lower end of this horn, or lever, to transmit its movements to the *upper* horns of the ailerons to effect lateral balance of the plane. The pulleys used to guide these aileron cables from the aileron control horn on the torque tube, into the wing butts, are well shown in Fig. 4.

The horn itself consists of two pieces of 18 ga. sheet steel, one of which is wrapped about the end of the torque tube and riveted and welded in place as

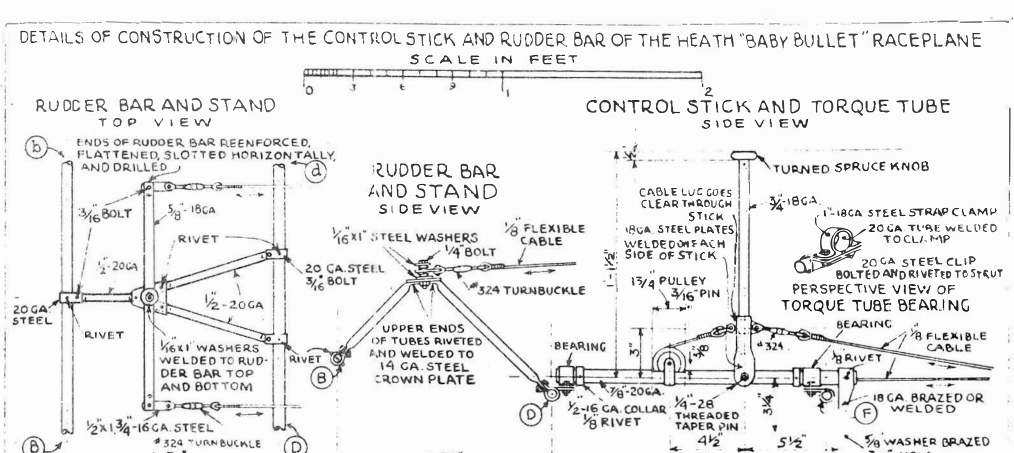


Fig. 7. Note the sturdy, simple assembly of control stick and rudder.

stern post, and the upper ends of this strap fitting form lugs for attaching the stabilizer brace wires.

Stabilizer Clip Fittings on Longerons

Stabilizer clip fittings as shown in Fig. 5 must be either welded or riveted to the top longerons. These clips are made of ⅝ in. 18 ga. strap steel, two-ply, welded to the strut fittings in front, and are ⅝ in. 14 ga. steel wrap-around fittings in the rear.

Application of Wire Bracing

The front half of the fuselage back to strut IJ is braced with No. 10 hard plated aircraft wire, with No. 324 turnbuckles installed at the wire ends and with clevis. The rear portion of the fuselage is braced with No. 12 hard-plated aircraft wire, with No. 324 double - eye turnbuckles installed near the centers of the wires with loop wire ends held fast in the clamp fittings by means of 3/16 in. bolts. Fig. 3, D, shows the correct method of making wire end loops. The main points to observe are never to bend the wire twice in the same place, and never to use a scratched, split, or defaced piece. Every turnbuckle should be safety-wired as shown in Fig. 3, E, to prevent disastrous loosening. Every bolt in the plane must be secured against loosening, either with a cotter pin or by a *slight* riveting. Solid anchorage at the stern must be provided for the top and bottom wires of the fuselage. Figs. 5 and 6 show how lugs riveted to the top and bottom longerons serve this purpose.

Truing the Fuselage

Make both diagonals in each horizontal top and bottom bay of equal length. Make all side struts square with their top longerons. In each bay of diagonal brace wires inside the fuselage, make both brace wires equal in length. It will take several hours to do a good job. When it is right, the fuselage will be true; all the wires will be in equal tension, taut but *not* tight, and they should hum a *low* note when plucked. When this is accomplished, safety-wire all the turnbuckles.

Still another inquiry which it is the purpose of the writer to forestall is in regard to the use of the wiring on this machine. Some have written to the editors of the parent magazine of the FLYING MANUAL, MODERN MECHANICS, and have asked whether piano wire, which is cheaper than aircraft wire, could not be substituted for the aircraft wire specified. The answer is no. Piano wire is of a type of steel which will crystallize rapidly under low vibrations. ●●●

COMPLETING THE FUSELAGE OF THE "BABY BULLET"

How the controls are built, how to make the seat, firewall, fairing, and other parts which go to make the "Babe" a midget sportplane are further elaborated in this second part on the construction of the plane.

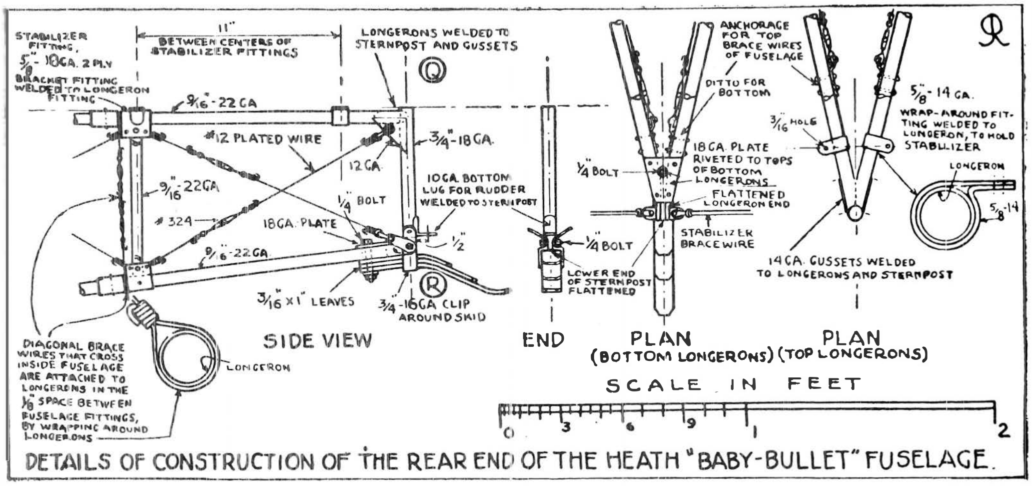
PART II

As to the arrangement of the cockpit: the pilot sits flat on the bottom of the fuselage with his legs extended to the front of the fuselage where his feet rest upon the rudder bar or rudder pedals, as the case may be. The control stick's lower end is situated between the knees of the pilot's extended legs, and its upper end is just forward of and below the lower edge of the instrument board. Fig. 7 shows the control stick to be of ¾ in. 18 ga. steel tubing, with a turned spruce knob inserted into its upper end and held by a rivet passed clear through the tube from side to side. Two 18 ga. steel plates formed as shown are welded to the lower end of the control stick to form a fork which embraces the torque tube, and is held to it by a ¼ in. — 28 threaded taper pin and two nuts. This taper pin is passed through the torque tube from side to side and is held in place by brazing. Its protruding ends are tapered for a short distance and then threaded at the ends.

The holes in the fork at the lower end of the control stick are reinforced by ⅛ in. steel washers brazed on. The holes must be tapered to conform with the taper of the ends of the taper pin. The control stick fork is attached by means of two ¼ in. castellated nuts and washers, the nuts being drawn up just enough to prevent any lost motion between the pin ends and the fork holes. The taper pin effect is used merely to make it possible to take up wear by tightening the nuts slightly from time to time. The castellated nuts must be locked on with cotter pins. The ends of the torque tube are carried in bearings attached to the horizontal struts "D" and "F."

These bearings are made as shown in the small detail drawing of such a bearing in Fig. 7, which is self-explanatory. The torque tube runs in a fore-and-aft

Fig. 5. This shows the details on the stern end of the fuselage. The tail skid, fuselage clips, longeron and gusset plate wiring are shown. The proper method of tightening wires is described in the accompanying article.



9/16 in. 22 ga. steel tubing. A splice is made at IJ by telescoping the 9/16 in. 22 ga. rear longerons into the ⅝ in. 20 ga. front longerons for about 6 in. and splicing as shown in Fig. 3, A. Three two-penny shingle nails are passed through each longeron splice as shown and riveted. The longerons are brazed or welded together at the end of the larger tube.

Sheet Steel Fuselage Joint Fittings

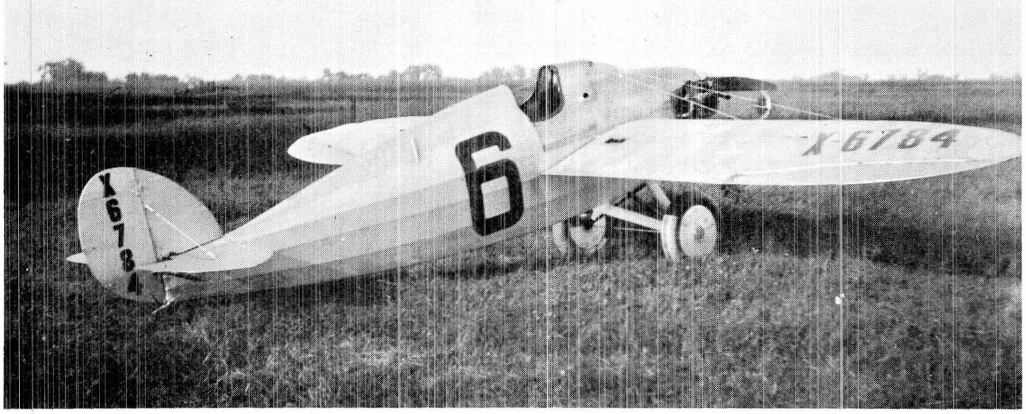
The sleeve fuselage joint fittings used in the rear part of the fuselage of the original "Baby-Bullet" are hard to make and in no way superior to the old easy-to-make "Super-Parasol" sheet steel, clamp, fuselage joint fitting, so the latter is here described. In Fig. 3, C, its construction is clearly shown. It is made of a piece of 18 or 20 ga. sheet steel of rectangular shape, which is bent around a short length of longeron tube and clamped in a vise as shown, until it clamps the longeron tightly and emerges a sleeve clamp fitting. It is installed on the longeron at a proper point for a strut end by passing one or two two-penny shingle nails through it and the longeron and riveting them. In Fig. 3, B, the method of preparing strut ends to make this joint is shown. A 2¼ in. piece of smaller tube is telescoped flush into the strut end, the end is heated red hot with a gas plate, clamped in a vise to flatten it, and drilled for the 3/16 in. fitting bolt. The end must be shaped to seat on the longeron when the strut is installed in the clamp fitting. Install all the vertical and horizontal struts. Note from Figs. 2, 5, that some of the horizontal strut clamp fittings are installed in front of the vertical strut fittings and some to the rear of them. A ⅛ in. space must be left between each pair of sleeve fittings on the longerons. The purpose of this space is to form a groove to hold the inside brace wires of the fuselage, whose ends wrap around the longerons, Fig. 5.

The stern post, see Fig. 5, is welded to the ends of the top longerons and is also held to them by two triangular gussets of 12 ga. sheet steel. Its lower end is reinforced and flattened to take the flattened and reinforced ends of the bottom longerons which are attached to it by a ¼ in. bolt passing through all three flattened ends.

Near the bottom of the stern post and on its rear face is welded, as shown, a bracket lug of 10 ga. sheet steel, which acts as a hinge lug for the lower end of the rudder.

The Tail Skid

The tail skid is composed of three leaves of 3/16 in. by 1 in. spring steel shaped as shown. A ¼ in. bolt passes through their forward ends securing them to an 18 ga. steel plate riveted to the tops of the extreme rear ends of the bottom longerons. The skid is secured to the bottom of the stern post by a ¾ in. 16 ga. wrap-around clip fitting held by the ¼ in. bolt in the bottom of the



Bob Whittier Photo

The Heath Baby Bullet as it appeared in 1928.

struts, making the cross section of the fuselage at any point a trapezoid, wider at the top. Now install the top horizontal struts Aa, Cc, Ee and their corresponding bottom struts. Now, true up with the aid of stove pipe wire, making both diagonal wires in each horizontal bay of equal length, then weld the horizontal strut ends to their gussets and longerons as this was done in the side panels. Now, returning to the study of Fig. 3, G, observe the triangular gusset with its edges welded to both "vertical" and horizontal struts in the angle they make with each other, and over which the end of a diagonal brace strut of cross section CDcd, see Fig. 4, has been slipped and welded in place. Put one of these gussets in each angle formed by vertical and horizontal struts with each other. In the cross section ABab they carry a pair of No. 10 hard-plated diagonal brace wires with No. 324 turnbuckles. Next install the diagonal tubes of the two sections shown in Fig. 4, working with greatest care, and fitting the gussets and tubes with all possible accuracy. Note that the large gussets in the centers of horizontal struts Cc and Ee are one-piece 12 ga. steel and *must* be made as large as shown to take bending stresses.

The cabane struts, though they scale 1 ft. 4 in. in length on the drawing, Fig. 2, are really 1 ft. 7 in. in length. This is because the drawing only shows a side elevation of the pyramid formed by the four struts. Their lower ends are fastened to the top longerons by means of the usual welded gusset joint of Fig. 3, G, while their top ends join in a weld, one pair to each side of a flat steel crown plate 1/4 in. by 1 3/8 in. by 2 in., at the apex of the four-tube pyramid. Along a line running about 3/8 in. below the upper edge of the crown plate are spaced at equal distances, four holes to take the threaded ends of the 10-32 threads to the inch, streamline, landing wires. These holes must be drilled through the crown plate at the same angle as that of the landing wires, so two must slant to the left and two to the right. To distribute the landing stresses, the front and rear holes should take the right hand, and the two center holes the left hand landing wires. An irregular washer must be cut for each hole in the plate and welded or brazed to it, in order to provide a good flat bearing for the nuts screwed on the ends of the landing wires.

Landing Gear Lugs

Note in Fig. 3, G, and Fig. 4, that the landing gear lugs are made two-ply by welded two 5/8 in. 12 ga. straps, one to the vertical strut and the longeron, the other to the horizontal strut and longeron. Finally they are welded together and the two-ply lug resulting is drilled with a 1/4 in. hole for the landing gear strut bolt.

Wing Beam End Fittings

In Fig. 4 the design of the wing beam end fittings is shown with very accurate measurements. Make two pairs, one right and one left hand pair, of 16 ga. sheet steel, locate them very carefully on their vertical struts and weld them to the strut as stoutly as possible. Now cut 1/2 in. 16 ga. steel strips and weld them by their edges to the long, unsupported edges of the fittings, and to the vertical struts. This will stiffen up the whole bearing for the wing beam ends so that the maximum strength of the wood may be developed.

Cross Section at EeFf

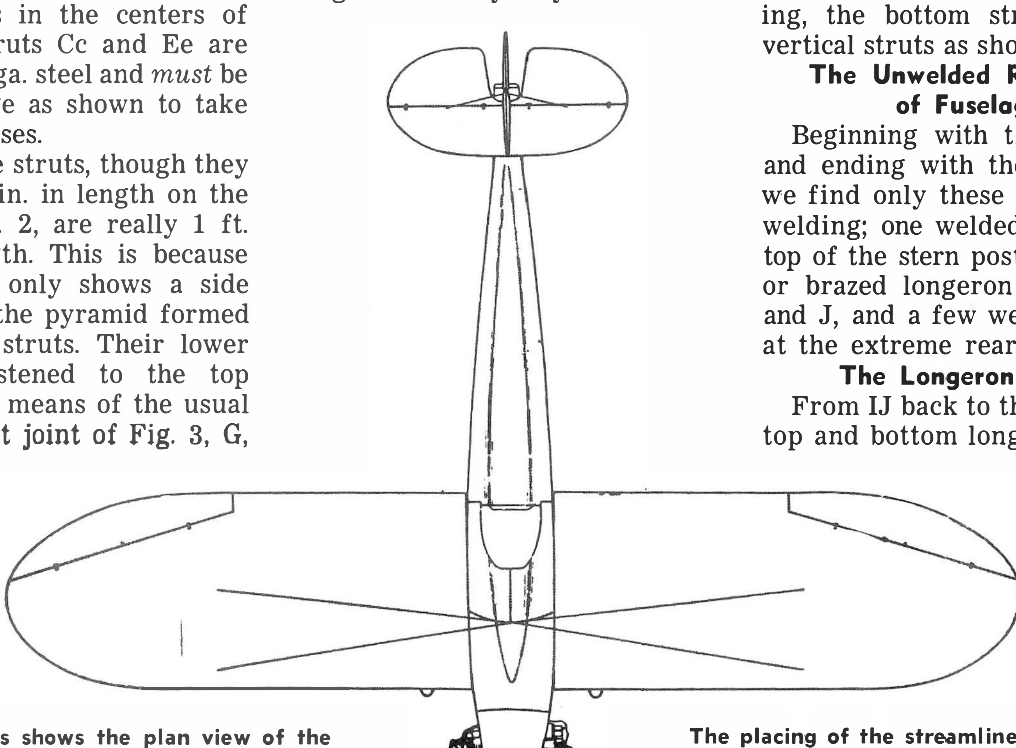
In Fig. 4 this section is shown with accuracy. Note the location of control stick and pulleys. The next installment will carry a full description of the controls. Curved pieces of 3/8 in. 20 ga. steel tubing are welded into the lower corners as shown for reinforcement. These corners are further strengthened by welding a gusset of 16 ga. sheet steel to this tubing, the bottom strut, and the vertical struts as shown.

The Unwelded Rear Part of Fuselage

Beginning with the strut GH and ending with the stern post, we find only these few cases of welding; one welded joint at the top of the stern post, the welded or brazed longeron splices at I and J, and a few welded on lugs at the extreme rear of fuselage.

The Longeron Splice

From IJ back to the stern post, top and bottom longerons are of



This shows the plan view of the Baby Bullet and gives a scale representation of the relation of all major parts. The oblique ailerons are no longer used.

The placing of the streamline tie rod cabane bracing is shown here; also note the split cockpit hood which opens to accommodate pilot.

lage of that material. It works easily and is easily obtained. Shelby seamless steel tubing is also satisfactory, but 1025 is generally preferred nowadays.

The design is for the 32 hp English Bristol "Cherub" motor and the three-view drawing of the fuselage, Fig. 2, shows a front end suitable for the attachment of a four-tube motor mount adapted to this power plant. It may need some shortening to hold a 4-in-line motor.

One thing which must be clearly realized in building this ship for personal use is that Mr. Heath is only 5 ft. 1 in. in height and, as the plane is quite snug for him, in case one is much taller than he, it will be necessary to move the cross section of struts GHgh several inches to the rear and to move the motor a few inches forward in compensation to regain balance. Change the ship as little as possible to get room enough.

To obtain the angle in the top longeron at C, the tubing must be sawed off at this point, the ends fitted to give the required angle, then butted together and welded all around. Carefully study Fig. 3, the full page of fuselage constructional details, noting especially Fig. 3, G, a typical welded gusset joint. Note the 12 ga. steel gusset of trapezoidal shape welded to the longeron. Make up a supply of these gussets and weld them at their proper locations upon the 5/8 in. 20 ga. longerons. Make up the left side of the fuselage first in a panel including ABJI. Now prepare the necessary side struts AB, CD, and EF. It is not yet necessary to make struts GH and IJ, as their ends go into unwelded clamp fittings wrapped around the longeron. As seen in Fig. 3, G, the preparation of a strut is simple. It is only a matter of filing the ends of a piece of tubing of right size to fit the longerons' surfaces, splitting the ends with a hacksaw far enough to allow the strut ends to slide over the gussets far enough to seat properly against the longerons. Install the struts in their proper places. No jig is necessary for welding the struts to the gussets and longerons. Just brace the bays with a temporary bracing of stove pipe wire fastened through the clevis pin holes in the gussets, see that the vertical struts are square with the top longeron, and then weld the edges of the split strut ends to the gussets and longerons. The front end of each longeron is allowed to extend about one inch beyond the strut AB, a piece of 9/16 in. 20 ga. tubing 4 in. long is slipped into the longeron flush with its end, and then the end of the longeron is heated cherry red and flattened vertically in a vise.

This flattened portion is then drilled for a 1/4 in. bolt of the motor mount. The right side of the fuselage is prepared in the same way. Now weld the horizontal strut gussets on the top and bottom longerons of both right and left sides of the fuselage, checking their angle with the "vertical" struts of the side panels, and noting that this angle is always an acute angle if it is a top longeron gusset and an obtuse angle if it is a bottom longeron gusset. This is because the top horizontal struts are longer than their corresponding horizontal bottom

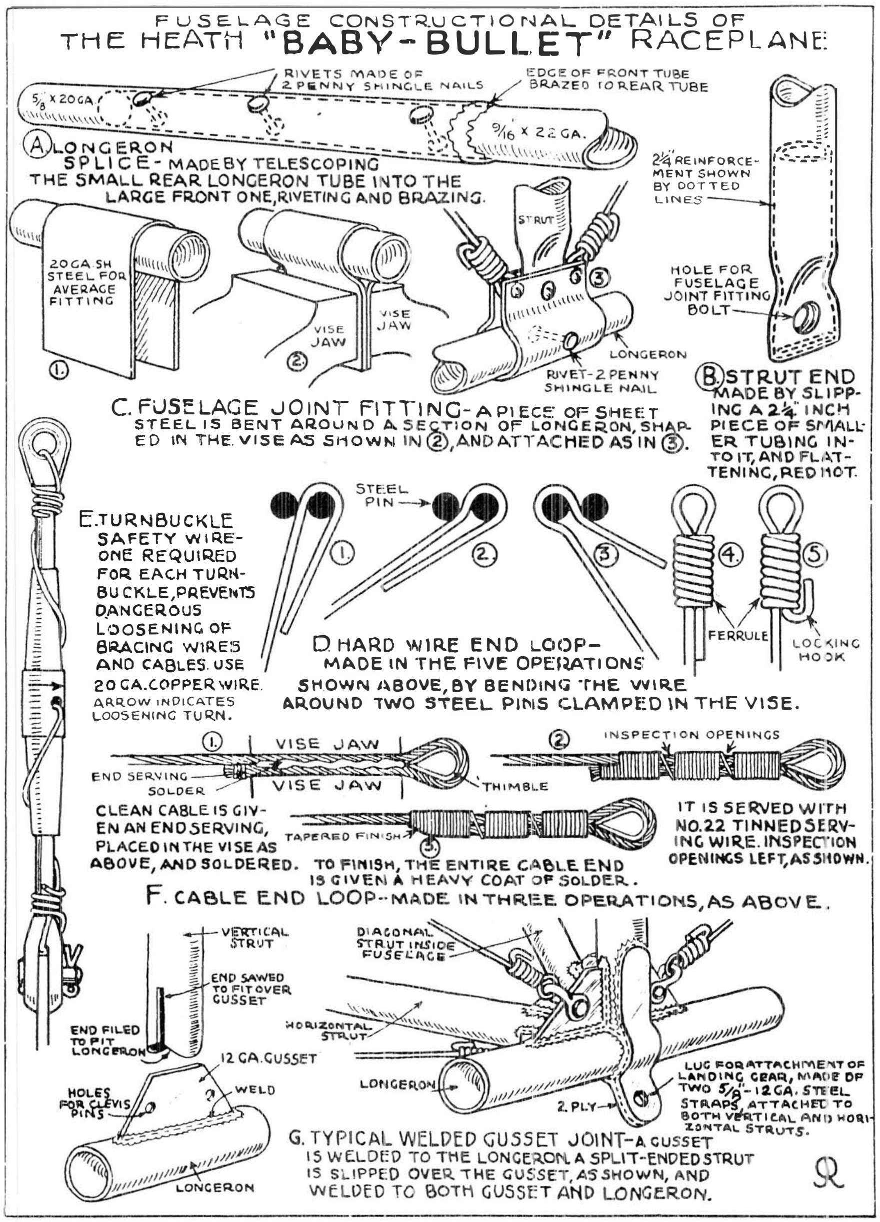
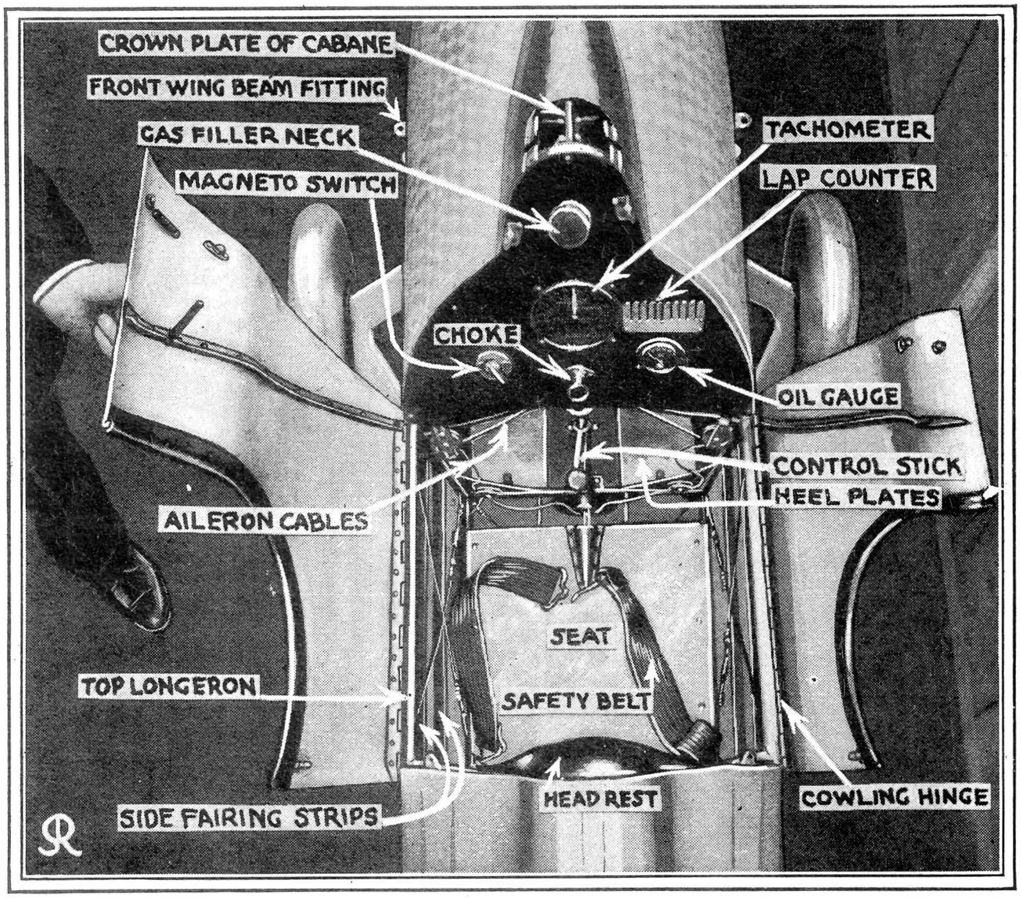


Fig. 3. This shows the manner in which the Baby Bullet fuselage fittings are made. Very little departure is made from the method employed by the Parasol, familiar to most lightplane builders.



What a joy to the heart of the amateur pilot is the instrument board and the cockpit layout of the little racer! She is virtually, in this regard, a miniature pursuit ship. Particularly interesting is the lap counter, installed to avoid improper running of races.

planes and their construction by building a duplicate of the record-breaking "Baby-Bullet" race plane, which requires a good field but which has *real* speed. And if one is a careful pilot and uses a *good* field, there is no reason why it cannot be used safely for what it was designed — intelligent speed.

Construction of the Fuselage

In writing this article the author will recommend several departures from the original construction of the "Baby-Bullet" race plane that are regarded as advisable either from the standpoint of structural strength, economy, or simplicity of construction. In each case the method used in the construction of the original racer will be described, the recommended change will be described, and the reasons for the change given.

In the original "Baby-Bullet", shown complete but minus fabric in Fig. 1 of this installment, the fuselage tubing is of two kinds, namely 1025 mild carbon seamless steel, and duralumin. In the front portion of the fuselage, where stresses are great, struts and longerons are of steel tubing with welded gusset joints, while the rear part, from the pilot's seat back, has struts and longerons of duralumin tubing joined with welded steel sleeve fittings riveted to the longerons and bolted to the struts.

These steel sleeve fittings consist of a sleeve of steel tubing which has a slip fit on the longeron to which it is riveted. But before it is slipped on the longeron, three steel gussets are welded to it, two for the vertical and horizontal strut ends, and one a good deal smaller than the others takes the end of one of the brace wires which cross inside the fuselage. The strut ends are split far enough with a hacksaw to hold the strut gussets and at the same time seat well against the longerons; and finally a 3/16 in. machine screw is passed through the strut end and gusset, the nut is tightened, and the strut end clamps firmly on the gusset. The entire fuselage structure is diagonally braced with hard-plated aircraft wire, with the exception of three bays. One of these is where the pilot's head and shoulders protrude, and the top wire bracing is tied together through this bay with wires lying against the longerons to take tension fore and aft, just as this was done in the old J.N.-4 training plane. The other two bays without diagonal wire bracing are the two cross sections shown in Fig. 4 of this installment. Fig. 4, however, shows not the original but the improved method of building the bay CDcd, which is vastly stronger, as the original has only triangular corner gussets for bracing. The brace wires were left out originally to provide more leg room, but with the improved CDcd bay, as drawn, the strength of the ship is improved without sacrificing leg room by merely introducing an inverted "V" of steel tubing as shown.

In view of the sturdy reliability of 1025 mild carbon seamless steel tubing, it would simplify matters to make the entire fuse-

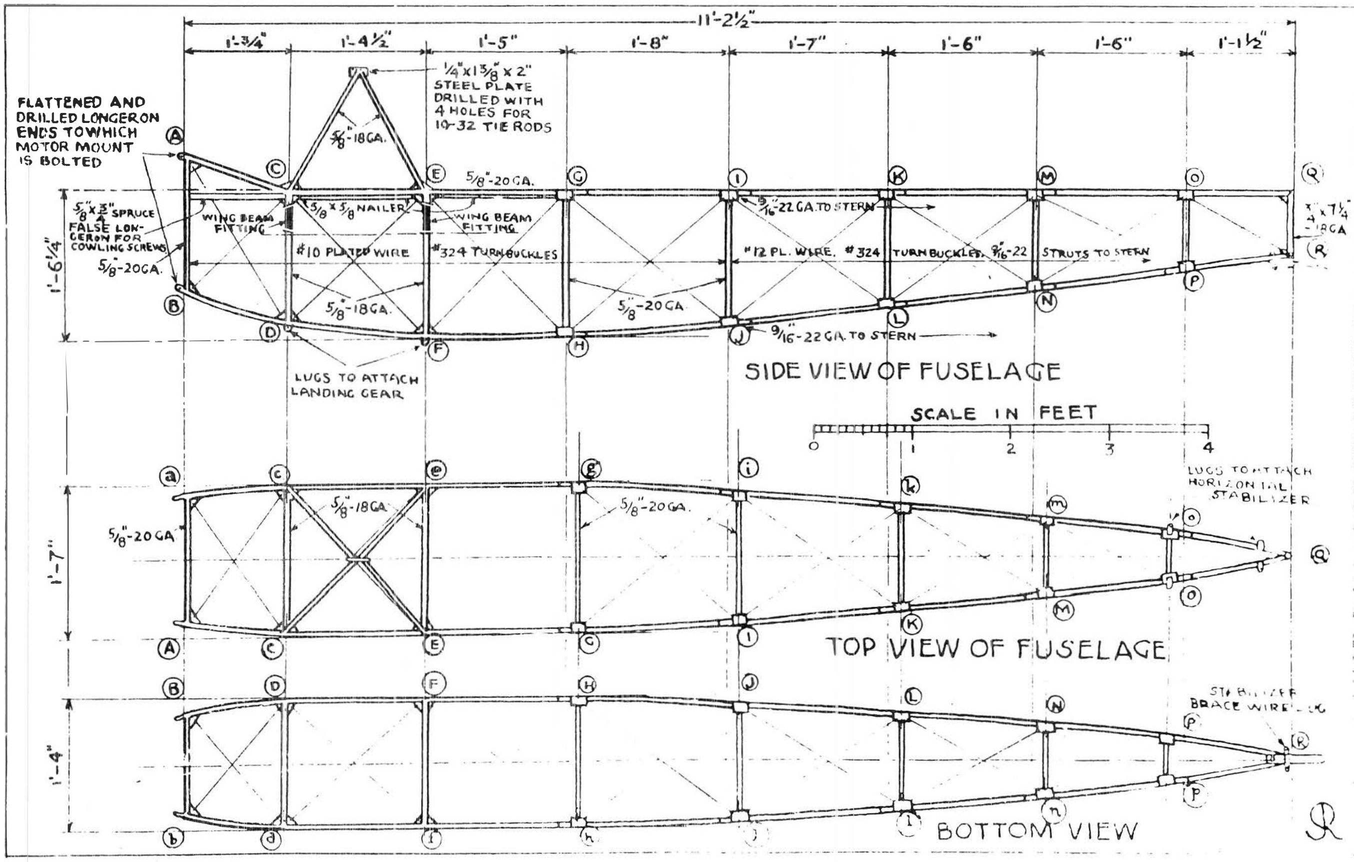


FIG. 2

ful light racing airplane. It produces what it was designed to produce — s p e e d sufficiently high to make it the fastest thing in the world for its horsepower. The DeHavilland "Tiger Moth", an English racing monoplane, has an appearance very similar to that of the "Baby-Bullet." It has four feet greater span than the "Bullet" and weighs about twice as much, and with 120 hp develops 186 mph. And as that is the best the rest of the world has done in the low-power field, the smaller plane has made an interesting mark for itself with its 150 mph top speed. The high speed of the "Baby-Bullet" brings its unavoidable result — small wing area, which makes this speed possible. This low area has another characteristic we do not like so well, high landing speed. High landing speed is not so disadvantageous for a large plane with huge wheels and brakes; but to land the "Baby-Bullet" safely, due to its high landing speed, small wheels, and total lack of shock absorbers, one must have a *large, smooth* field and considerable skill. The "Bullet" lands at from 55 to 60 mph. Take-offs are easy and it usually is in the air after a 75 ft. run. If one makes a landing on a rough patch of ground, the jolting received is pretty bad, as the pilot is the only shock absorber in the little plane. A forced landing, away from known fields, would be very worrisome and perhaps difficult. For touring and joy flying, a "Super-Parasol", or other general purpose sport plane, is fine, but for *real* speed, where there are good fields, the "Baby-Bullet" is the ship. Just as a great deal about automobiles and automobile building can be learned through building a refined little dirt track race car which cannot be driven off a speedway because of its small road clearance but which has real speed, so can a great deal be learned about air-

Bob Whittier Photo

Designer/Builder Ed Heath proudly displays his outstanding Baby Bullet.

oldest airplane factory and supply house in America, and all that was in it. Thus the first "Baby Bullet", known as the "Wee-Mite", was destroyed.

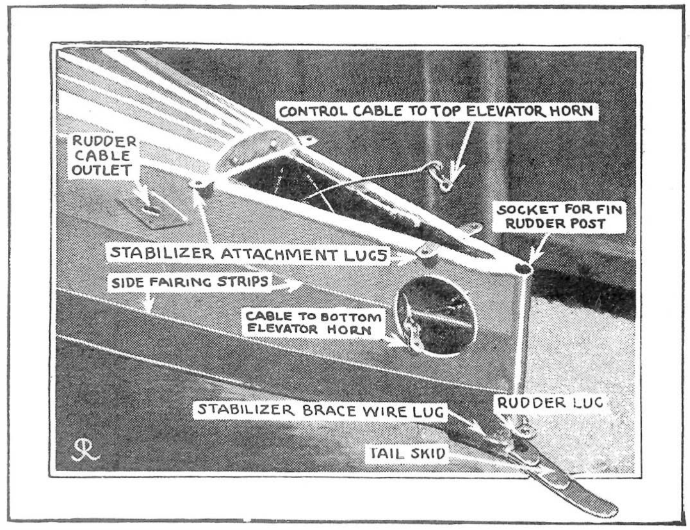
Another factory was secured and construction begun on another racing airplane identical to the "Wee-Mite", to be known as the "Baby-Bullet." It was put through very gratifying trials August 23, 1928, the day after its completion. The author of this article saw these trials, helping a newspaper man in securing a head-on view of the "Bullet" about 15 ft. from the ground, just after it had flattened out of a dive. The speed may have been 200 or 250 mph — at any rate, it was indescribably fast, and it is rather bewildering to see a man in a plane that looks about as large as two side-cars hurl at one like that, and then zoom with squealing wires back up to 1,000 ft., before one's brain begins to wonder if the picture just taken is any good. Well, we got the picture, and it is in this article. It is not to be supposed that Ed is a reckless pilot; the maneuver described was made merely to get a sensational photo.

The "Baby-Bullet" was shipped to Los Angeles in two beautifully made crates. The wing crate was about 1 ft. by 4 ft. by 9 ft., and the fuselage crate was 2½ ft. by 3½ ft. by 13½ ft. On arrival at Mines Field the little racer was unofficially timed around the five-mile triangular course at an average speed of 142 mph, and during this test it easily passed an army plane which was also flying the course and has an official top speed of 145 mph. The propeller used was 4 ft. 4 in. long with 3 ft. 6 in. pitch, Heath-made of walnut. It turned 3450 rpm at top speed, 2700 rpm in a steep climb, and 2800 rpm on the ground.

On September 14 Heath won the 300 cu. in. race for light planes and sport planes, defeating among seven other contestants a D. H. Moth flown by Mr. Carbary of Toronto. The race was for 50 miles around the five-mile triangular course at Mines Field, from a standing start, and Heath, carrying a load of 75 lbs. of iron, with the motor turning 3150 rpm averaged 112 mph. Even at this rather slow speed the "Baby-Bullet" lapped most of the field three times, and the D. H. Moth twice. The purse was $1,500. This purse made Heath's total winnings from three years of racing the same motor, $5,000. The motor's original cost was $1,270.

The "Baby-Bullet" is a success-

The steel spring tail skid, described in this article, and the various fittings described in Fig. 5, together with the detail on the flipper clips are illustrated by this photo.



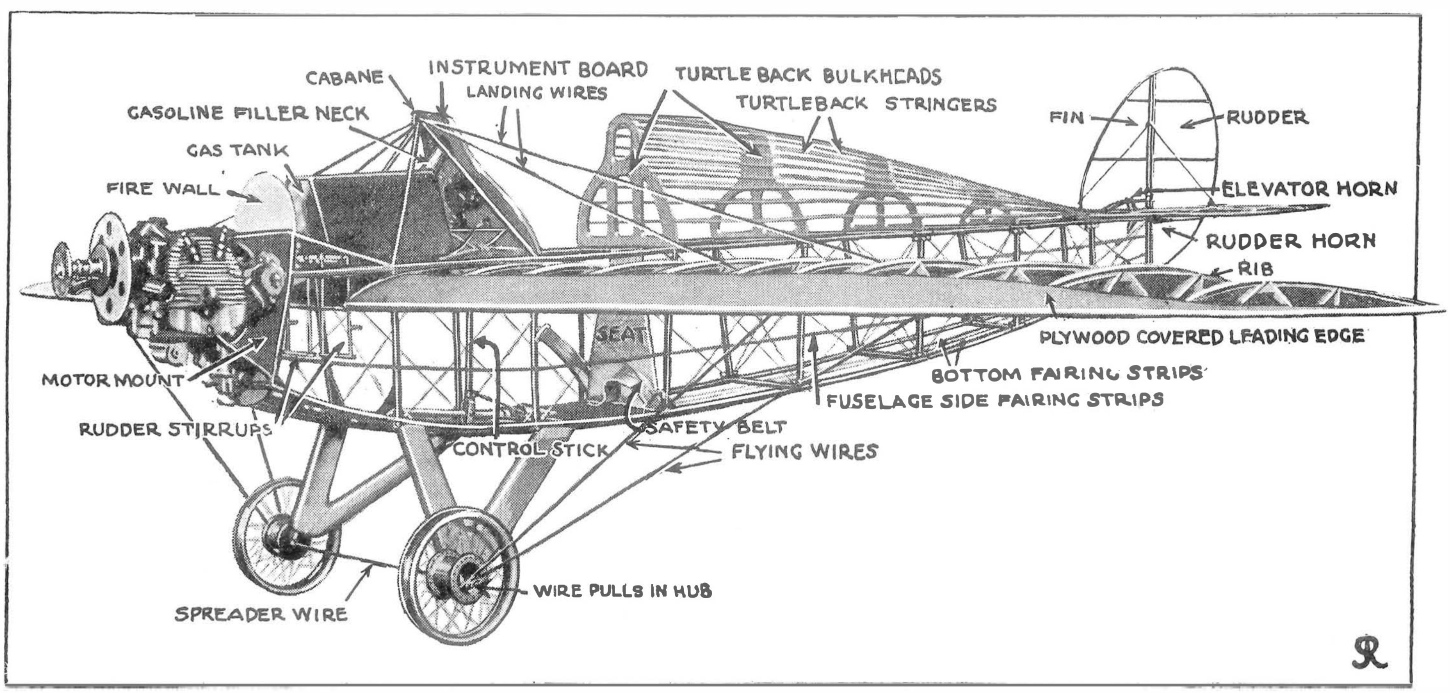
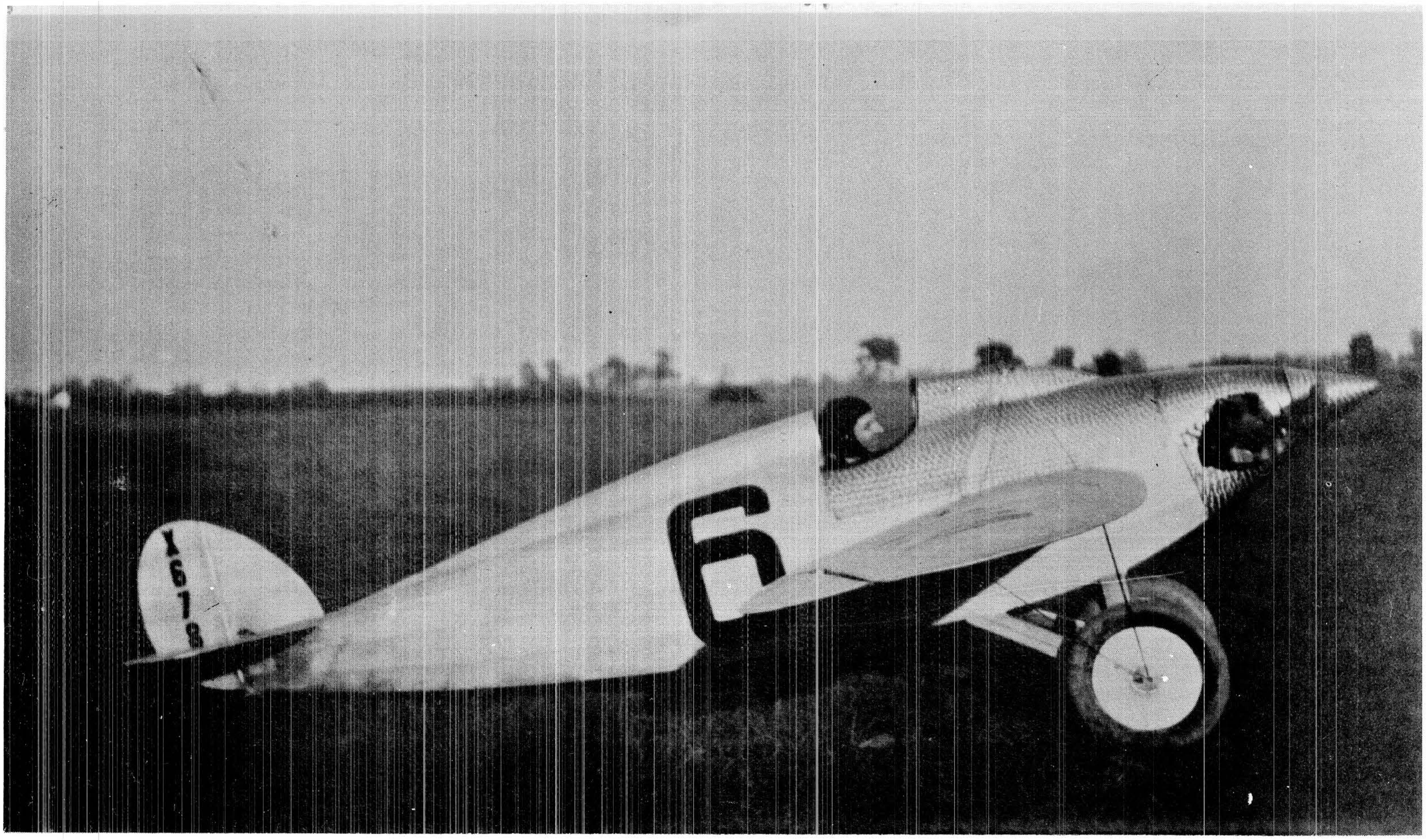


Fig. 1. Photo shows all structural details of stripped "Bullet" clearly.



The 1928 Baby Bullet looked fast on the ground . . . in the air nothing in the air could touch it. Ed Heath in the cockpit.

Bob Whittier Photo

PLANS FOR BUILDING THE "BABY BULLET"

By Stewart Rouse

Faster than anything that flies, horsepower for horsepower, Ed Heath's "Baby Bullet" has won over $5,000 in prizes at recent air meets. For the first time in the history of American publishing, Modern Mechanics presents herewith complete how-to-build for a successful racing airplane — one which you can build yourself!

PART I

"Ed" Heath, that unassuming fellow whom we like to think of as the dean of American light-plane designers and pilots, is a very energetic man.

The Bristol Cherub motor, of his "Spokane Super-Parasol", had hardly cooled from the work of winning the light and sport plane races of the 1927 National Air Races at Spokane, with the $1,000 he had won in prize money still making his purse heavy, when he began to plan a light race plane which would show its tail skid to the field at the 1928 National Air Races at Los Angeles.

As he made the long trip back across half the continent to Chicago, his mind was not occupied with the races he had just won, or those he had won in the past. He was concerned with the earnest contemplation of a new racer to embody the best of engineering, the latest knowledge of aerodynamics, and the counsel of experience gained in 20 years of practical aircraft building — a race plane which should be the smallest practical airplane in the world, should carry a man and 75 pounds of ballast in addition to fuel, should do this at the speed of 2½ miles per minute, and use only *32 hp!*

The plane was finally built and ready for flight trials. It had been seen and much admired by the flying men of Chicago, for Ed is never secretive and visitors are often seen in his factory. Unfortunately, just at this point, in the spring of 1928, a disastrous fire burned the main factory, the

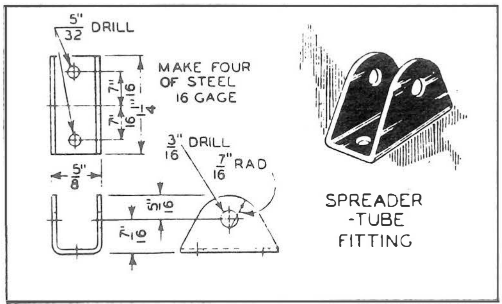


Fig. 6. This shows the weight metal generally employed in most landing gear chassis. See note in article on bending.

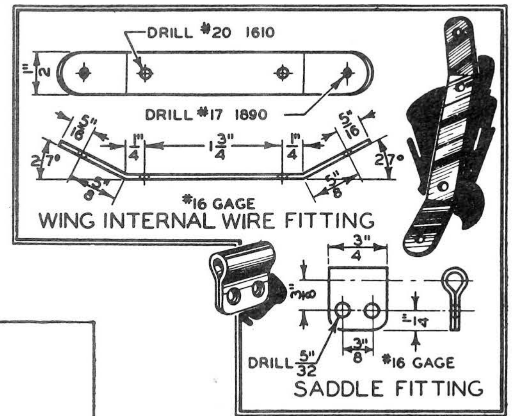


Fig. 10. These are fittings for the wire clips and drift wires in the wings and fuselages of modern lightplanes.

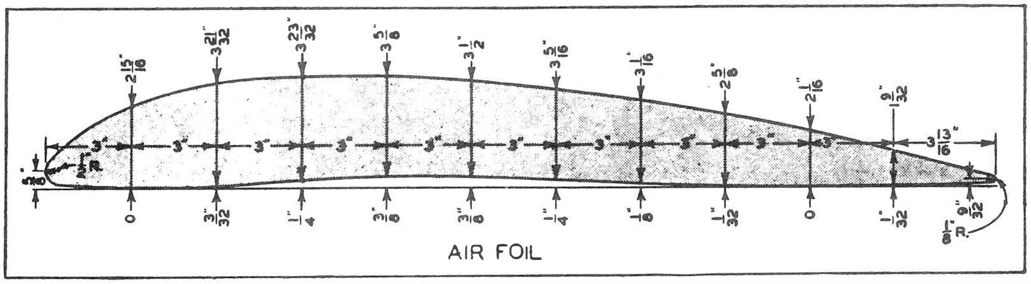


Fig. 7. This is the Lincoln Sportplane wing template as dimensioned for use in laying out the ribs. Dimensions are taken from the graph shown in the article on Choosing Your Own Wing Curve.

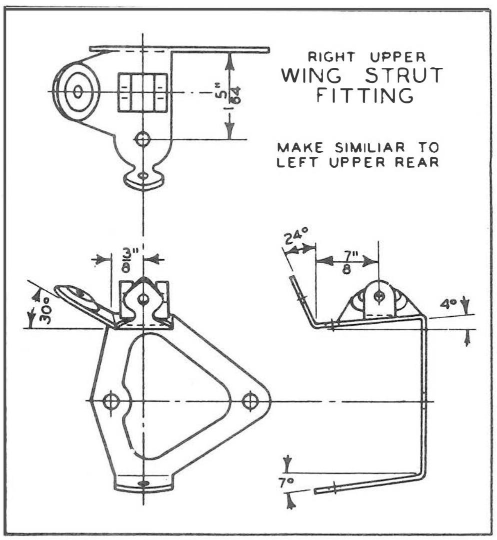


Fig. 8. The principle of follow through is shown in this fitting. Note that the 30 deg. wire clip angle is followed through with a strap to the center of the spar.

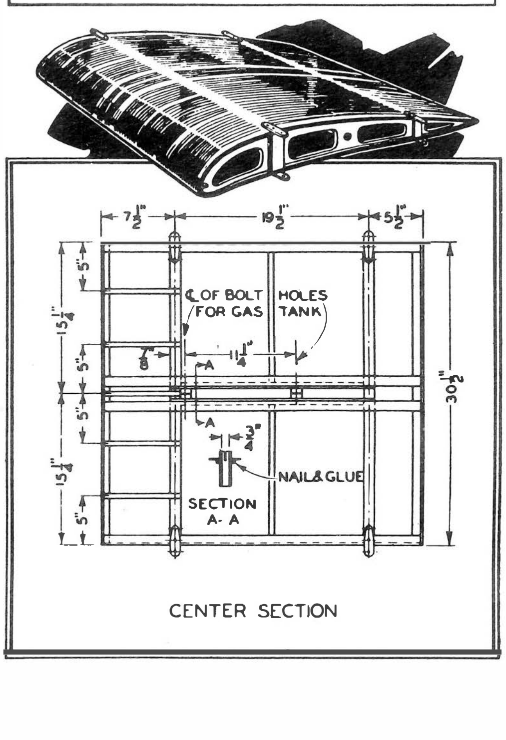


Fig. 9. Center section construction as used on the average light biplane is shown above with full measurements which will give an idea of this part of the plane.

tion of the Baby Bullet in this issue of the *Flying Manual.*

Fig. 6 shows a good fitting for the spreader tube socket. It is interesting in that it prescribes 16 gauge c.r.s. for the proper metal.

Center sections, such as the one used on the Biplane, may be a trifle out of line for consideration with so many simple monoplane designs, but it is interesting to see what sizes the builders of today prescribe for the dimensions. The center section is the keystone in biplane rigging.

Fig. 8 shows another type of wing strut fitting which has a cut-away section to lighten it. Some places where extreme lightness is needed to save weight the fitting shown is used. Note it has an apex which follows through with the flying wire.

That is an important point in all airplane construction, this question of follow through. It means that a fitting or a spar or a strut is so designed that the forces are concentrated at the neutral axis of the part the force is acting upon. One wouldn't think of putting a crank out on a wing and then fastening the flying and landing wires on it! Then why not have everything line up so that there are no parts taking eccentric or off-center loads? Good airplane fitting designing requires that follow through be paid plenty of attention to.

Saddle fitting for pulleys and wire clips, as well as internal wing wire fittings are shown in Fig. 10. The drawing is self-explanatory.

The amateur builder will find little difficulty in constructing his own fittings from the information which he has gleaned by a reading of these pages. A good deal can be learned from visiting the local airports and seeing how the fittings used by modern production ships are made. If care is used to make the metal the thickness required in the right place as shown by the fittings in this article the amateur builder need never worry about the strength of his plane. ● ● ●

plane weighs not over 500 lbs. loaded and has a wing span of not over 21 ft. with single bay struts.

Control pulleys?

These can be the same for all planes. The idea is to keep them light. Fig. 2 shows how they can be made.

Fig. 4 shows a good cage for the pulleys. Such a cage or shackle can be used in the fuselage and in the wings for the control of ailerons. The fitting shown has plenty of strength for all lightplanes, even for two-seaters.

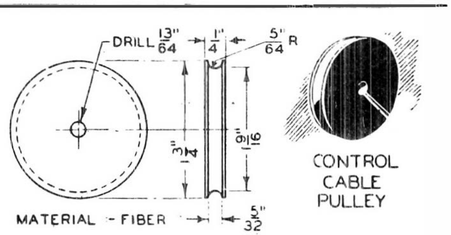
Wheels for landing gears can be purchased from almost any airplane supply house. Here let the writer say that while the usual 20x2 tires and wheels *may* be used, they are not satisfactory for wet fields, and they often buckle. They groundloop readily. It is far better to invest a little more money and purchase the 18x3 tires and tubes.

The landing gear construction in lightplanes had best be of the spreader bar type with the low unsplit axle until present day designers come out with a sufficiently clever split undercarriage the the average amateur can build. The type meant is the same used by the jn-4Ds, the Waco nines, DHs, and others which have the tripod arrangement with the axle floating on rubber shock cord.

A good anchorage for the shock cord is shown in Fig. 5. The tube is constructed as the drawing shows. The spreader bars are as shown. The method of joining the wooden Vees of the landing gear is also shown.

The laying out of the airfoils from graphs is shown in Fig. 7.

Fig. 2



Pulley blocks of generous, easy running diameter can be made on a lathe using fiber for material. Here is a good example to follow.

The curve shown is the U.S.A. 27, dimensioned for use with the Lincoln Sportplane which is published in this issue of the *Flying Manual.*

The ribs are made by sawing out a wooden template to exact size, then nailing a half dozen of them together, sawing them to the outline as decribed by the template. Then saw cuts are started from the edges where the spars are marked, leaving a little tab in the middle which will hold the ribs together until the cap strips are put on. Then with a keyhole saw the space for the spars can be cut out and, presto! The rib is done!

The method for building the trussed types of ribs with plywood gusset plates, is shown by Stewart Rouse, one of the best light airplane authorities in the country, in his article on the construc-

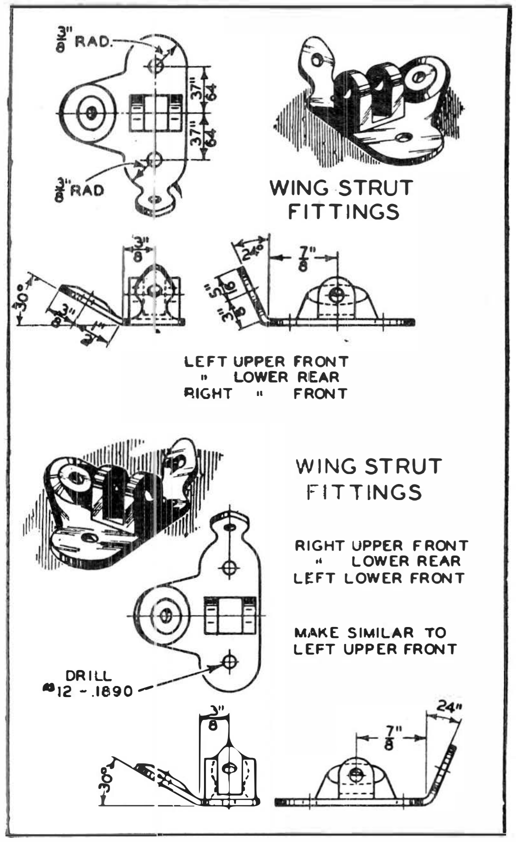


Fig. 3. The method used in building up a wing strut fitting is shown by the above dimensioned cut. The tabs are welded after bending is done.

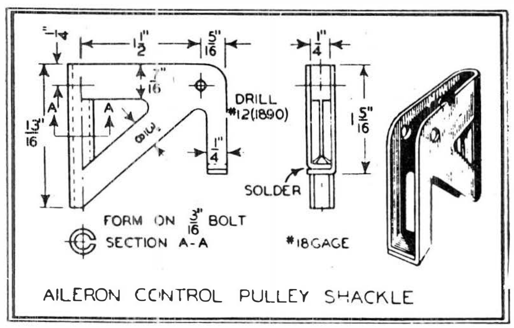


Fig. 4. Here's a typical cage or shackle for either fuselage or wing pulley use. Note how it is lightened.

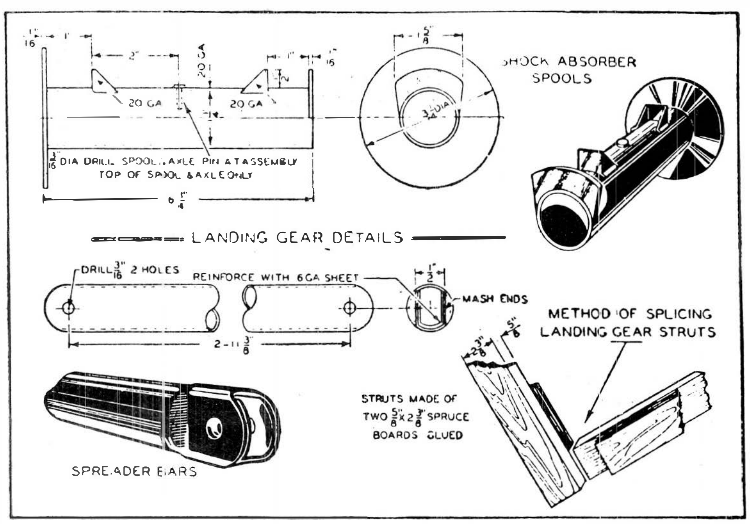
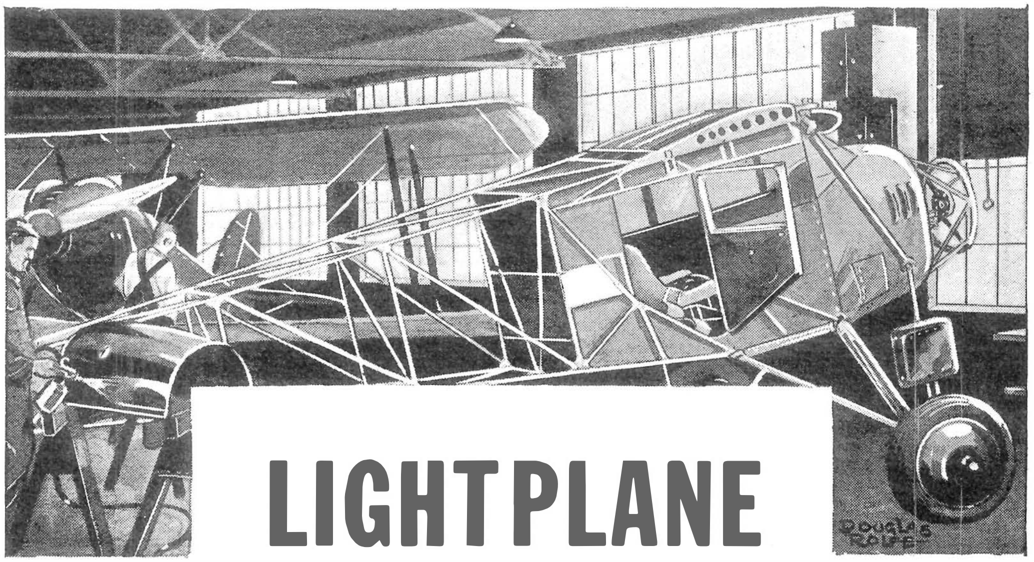


Fig. 5. Details for building the usual orthodox floating axle type of undercarriage for lightplanes. Note collar for containing shock cord.



LIGHTPLANE FITTINGS

To most amateur airplane builders one of the most difficult of stumbling blocks is the building of the proper kind of metal fittings.

If the fittings are properly built as outlined in this article, and are made with an eye to the reduction of internal strain on the part, the metal fittings described may be used with absolute confidence on any light single seat airplane of not over 50 hp.

You see, friend reader, it is a matter of loadings — how much work is expected of a fitting, and how the load is placed, that determines whether a fitting is too large, too heavy, or too light and weak.

The factor of safety is the starting point.

Most light single seaters have an inordinately high factor of safety. It varies between six and ten. That means that the plane in its weakest part is six to ten times as strong as the worst possible load that can be put on it in flight.

So when you have a definite weight of crew, say 200 lbs., and the ship loaded with gas and oil, but minus crew weighs 300 lbs., you have a definite point of departure. Now, if the wing struts, for instance, are four in number, and the normal load of the plane is 500 lbs., and the struts are taking the load in a direct line, the load on each strut would be 125 lbs., so that each strut takes its load according to its placing. Designers try to keep the front and rear spars of a plane equidistant from the center of pressure of the wing.

Then for a factor of safety of ten, the breaking point of a fitting designed to handle this normal 125 lb. load would be 1,250 lbs.

If you care to, tests can be made of each fitting in a similar manner for the whole plane. It is not necessary, though, for the fittings used on one plane with about the same loading, can be quite safely used on another plane with the same total loaded weight and the same angles as the joints.

Therefore, if you have a knowledge of the types of fittings used on one lightplane you will be enabled to intelligently select the thickness of metal and the type of fittings you want to use on your own plane.

To that end the drawings of the fittings for a very good lightplane, built by O. H. Snyder of McCook Field and powered with a twin Indian with chain reduction drive, are shown in part. The drawing, by Douglas Rolfe, shown on the inside back cover, gives a good idea of the plane.

Now for instance you have designed a small biplane and you want to know what kind of a fitting to use for the wing struts.

Look at Fig. 3. You will see 18 gauge c.r.s. (cold rolled steel) which is cut to a template made of hard paper. The bending is done cold — never heat a fitting — and the bending, by the way, must be "bending." It will not do to hammer the metal unless you are working with very thick sheets as the hammering tends to make the skin fracture on the outside of the bends. The turnbuckle eye pieces are welded on after the fitting has been made. (See Orville Hickman's story on welding in this Manual). The wing strut receptacle is cut out of a solid piece of c.r.s. shafting with a file and riveted and welded to the sheet metal fitting. This fitting is typical and can be safely used on all wing strut fittings where the bi-

Wright Brothers is in use today. The slotted wing and other comparatively recent developments for even greater ease of control have no place in this chapter. In the matter of connecting the control surfaces to the controlling levers there has been a remarkable movement toward standardization. From the weird tangle of devices used in the pioneer days of flight, quite early there emerged the single stick control and rudder bar. The invention of this system is generally credited to M. Robert Esnault Peltrie, a French engineer who applied engineering methods of construction to planes in a day when hardly ten men had flown.

The general control system in use today may be classified as stick and rudder bar for light and moderately heavy planes, the heavier transport planes being equipped with a combination stick and wheel for elevators and lateral controls respectively, with the usual rudder bar or pedals for operating the vertical rudder.

The stick and rudder bar system has the advantage of being so arranged that the necessary movements for correcting deviations from the flight path are almost, if not entirely, instinctive. You wish to descend, you push the control stick forward. To climb—the stick is pulled back. Reversing the procedure; perhaps you are diving too fast, just pull the stick back gently. The same instinctive movements apply in the operating of the lateral controls. The airplane is tilted sharply by a sudden gust of wind. Automatically the pilot seeks to maintain his upright position and if it is the left wing that has tilted he simply pushes the stick towards the left, that is to say, the high wing. As mentioned earlier, movement of the stick produces certain definite movements of the control flaps, in this case the wing flaps, and the plane is immediately righted. To turn left, the pilot pushes his left foot forward, thus tilting the rudder and causing the plane to turn in the direction desired. As he is turning to the left it is also necessary to tilt the plane on a left bank so a movement of the stick to the left depresses the left wing and raises the right one, thus giving him the position he desires. These are naturally very loose descriptions and are used merely to demonstrate the general actions necessary to produce certain specific results. Flying has to be learned and it admittedly takes more than a mere knowledge of the controls to acquire a pilot's skill. A knowledge of the controls and their purposes is, however, of vital importance to the would-be pilot and fortunately the mere beginner is now able to put himself in possession of more real knowledge before he even steps into a plane than all the early pilots and designers dreamed of. • • •

BUILDING A LIGHTPLANE

Modern Mechanics, always leader in the American magazine field in the quality, quantity, originality and authenticity of its how-to-build articles, is championing the cause of the light airplane. The airplane plans presented in this chapter of the *Manual* are the finest ever published.

Just what is a lightplane? If a light airplane is such a good medium of teaching Young America the ways of the air, just what are the possibilities and limitations of this lightplane movement?

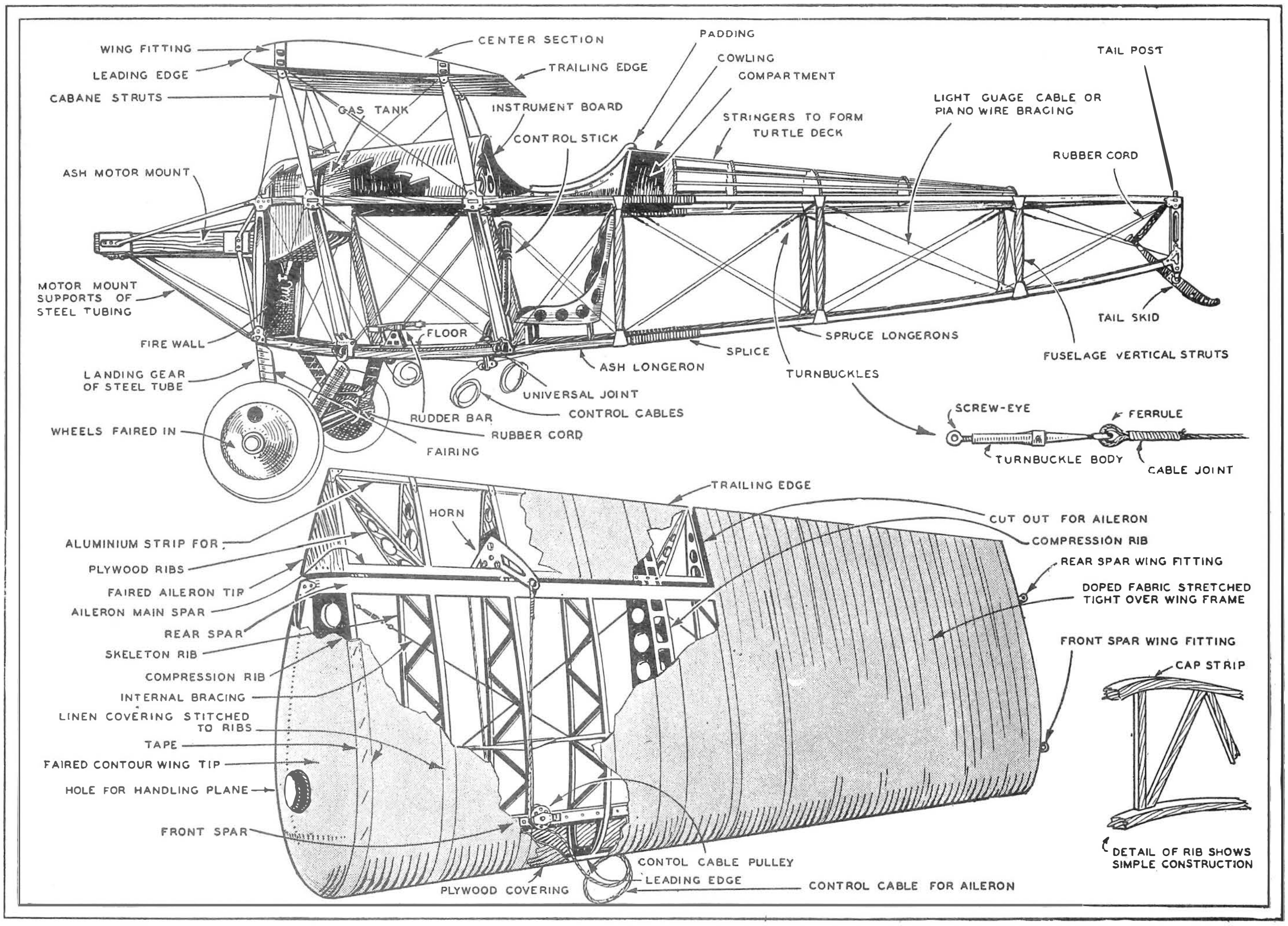
A light airplane is taken arbitrarily to mean a machine which weighs less than 500 lbs. loaded, propelled by a motor of seldom more than 80 cu. in. capacity, or of around 35 hp or less.

Within these limitations an airplane can be built which will carry a single passenger (the pilot) and give a performance equal to almost any of the commercial ships extant, pound per horsepower of loading. The little ships built to conform to this general classification of power and weights are thoroughly airworthy, are inexpensive to own and maintain, and will prove the cheapest way for any young man to become air-minded, win his wings, and build up the 200 hrs. necessary before the U.S. Dept. of Commerce will grant him license to fly anything any time, anywhere.

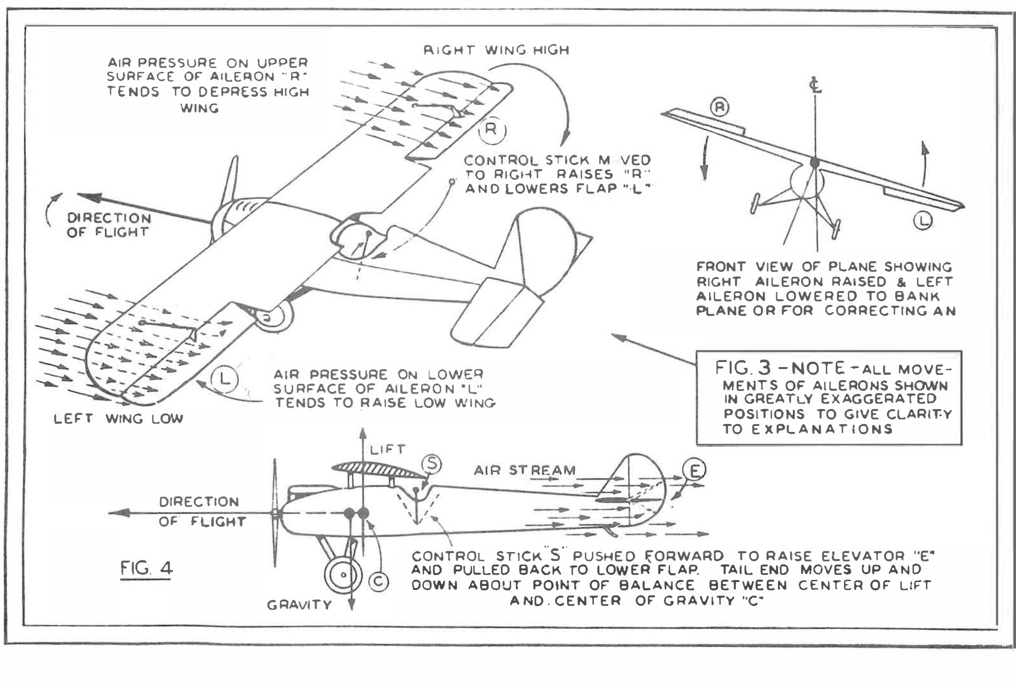
No ships like this are on the market in great numbers. The Heath Super Parasol, manufactured in Chicago, is the only one in regular production. But tastes among ships vary, and as the plans for an airplane cost a great deal of money, it is impossible for the lightplane enthusiast to dip into his pocket and buy a variety of designs to take his pick from. *Modern Mechanics Flying Manual* is performing this function for him. We spend hundreds of dollars with various designers of tried and proven planes, and in the last *Flying Manual* presented plans for the Super-Parasol, Russel Sport Monoplane, Duede Glider, and T. A. Hodgdon's article on the conversion of lightplane motors. Here in this second or 1930 edition of *Flying Manual* further plans are given. The ships presented are the last word in modern lightplane design, and will do much to further the movement inspired by the British when they inaugurated contests for gliders at Lympne, in 1923.

From that initial contest in which some marvelous performances were put up by ships which were nothing more than gliders powered with light motors, the present lightplane has evolved. Annually in the United States there are races for ships of the lightplane variety, and substantial purses are awarded. Witness Ed Heath's $5,000.00 winnings with the Baby Bullet.

So here you are! On the following pages you will see the latest presentation of the world's best lightplane plans. The stories speak for themselves. Go to it, Gang! • • •



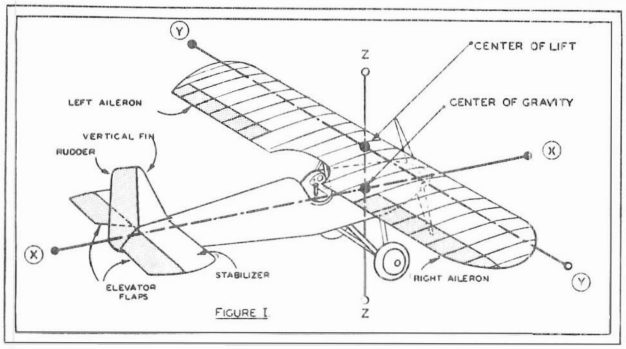
Here are the salient points of an aircraft. The features illustrated here form sort of an anatomical chart of airplanes, for the majority have parts in common with this little one seater sportplane and its wing panel. The "stick and wire" form of construction is still useful, simple and cheap, and a great many airplanes still fly that were built before the steel tube construction, replacing wood, became practical. Steel tube fuselages are essentially the same; wings still are "wood and wire."



Although the movements of the ailerons are greatly exaggerated in Fig. 3, the diagram serves to show how the passage of air throws the ship down in the direction the stick is thrown. Fig. 4 shows the relation of the weights in a plane to the center of lift. Actually, but very slight motions of the stick are necessary to give proper control. Fig. 4 shows relation of forces.

of the flap that has been lowered. This will tend to lift the wing. At the same time pressure is being applied with equal force on the upper surface of the opposite wing flap (now in a raised position), tending to lower the wing. Thus if the pilot wishes to raise his left wing he pushes the stick to the right, thereby lowering the flap (see Fig. 3), attached to the left wing and raising the flap on the corresponding or right wing. If the airplane is tilted by a gust of wind the pilot is able to immediately correct the tilt by means of the flaps or ailerons, the usual procedure being to push the control stick toward the high wing, an almost instinctive movement. The function of the wing flaps is not only for the purpose of balancing the plane laterally but also to deliberately tilt the plane when it is desired to bank, as is necessary in turns, much the same way as it is necessary for racing automobiles to bank when turning at high speed. However, in case of the automobile, it is not possible to bank the machine itself, consequently they require specially constructed race tracks with banked curves built up.

The operation of the elevators is readily understandable with the airplane. In a normal flying position the elevator flaps are in a neutral position and the air pressure is equal at the top and bottom. In this position there is naturally no movement up or down of the tail group and the airplane maintains normal flight. If the elevator flaps are depressed pressure is immediately exerted on the lower side of the flap tending to raise the whole tail and forcing the nose of the plane down. By reversing the position of the elevator flaps the air current is directed against the top surface of the flaps which tends to force the tail down and point the nose upwards, as in climbing. (Fig. 4).

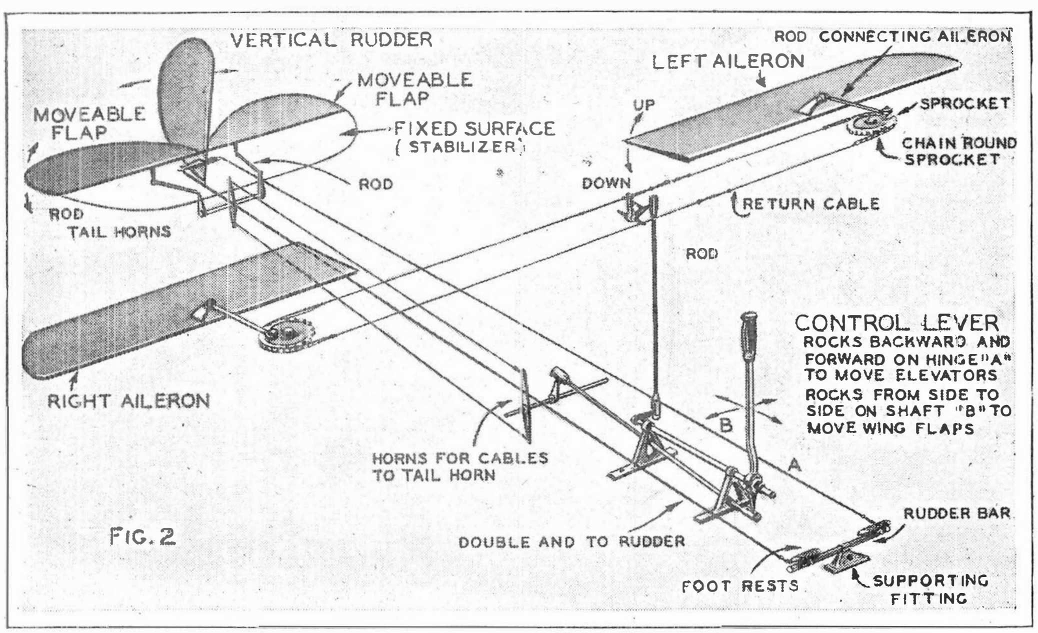


The shaded areas represent the movable surfaces which give the airplane its directional control. Elevators control diving, or climbing. The rudder controls turning, and the ailerons maintain lateral stability. Each must be moved in relation to the other as explained in this article.

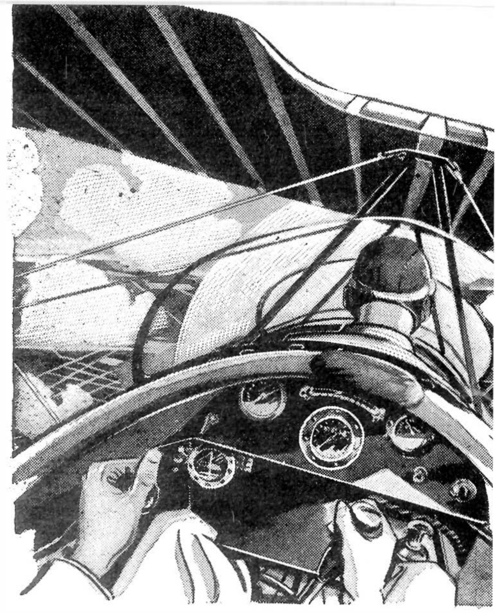
The same action applies in the case of the vertical rudder when it is moved right or left. The pressure of the air stream against the inclined surface pushes the tail end of the plane around in the same way the stern of a boat is swung round by the action of the rudder. In designating the axes around which the airplane is free to move it is well to bear in mind that the center of gravity of the plane (shown in Fig. 1), is always considered the equilibrium point about which the control surfaces tend to act. The principle of the control of an airplane may be likened to a lever having its center of support resting on the point of support of the airplane, that is to say, the center of gravity. For instance, pressure applied to the control surfaces at the end of the fuselage by the raising or lowering of the elevator flaps causes the fuselage to rock up or down depending on which side the pressure is directed, however. It always moves around the center of gravity.

The method of control just described has, with the exception of some of the very early years of aviation, been used on all airplanes up to this day. Minor refinements have been developed and great advances have been made in the development of areas and forms suitable to obtain the greatest degree of efficiency in control surfaces, but broadly speaking the same control system employed by the

This shows exactly the method by which the controls are interconnected. The method by which dual controls work, and the relative movements of the surfaces with regard to motion at the controls can be plainly discerned. Note in the above drawing that the ailerons are run by cranks.



THE PLANE and its PARTS



By Weston Farmer
Naval Architect and Light Plane Designer

How Control Surfaces Act — The Control Stick Hook-up — What an Airplane Looks Like Stripped of Fabric — How a Wing Is Built — What the Lightplane's Fittings Are Like — The Strength Needed for Safety — Landing Gear Construction — The Strut Fittings — The Spar Fittings — Parts for a Typical Lightplane.

In an accompanying article Mr. Driggs has clearly presented the underlying principles of flight. We have seen how it is possible to overcome the force of gravity by means of artificially induced lift and are readily able to understand that the airplane which appears to be so precariously skimming through space is in fact firmly supported in its natural medium, the atmosphere.

In order to understand controlled flight it is necessary to realize that the airplane is free to move about three separate axes in addition to its forward path through the atmosphere and that some mechanical means must be employed to control the movements about these axes if balanced and controlled flight is to be attained.

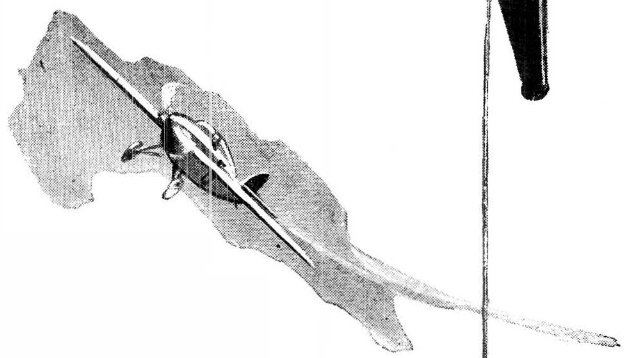
The system of control now universally employed embodies three distinct sets of movable flaps or control surfaces which are attached to the main structure of the airplane in positions calculated to insure a definite control of the movements about each of the three axes in which the airplane is free to move. The simplest way of describing the location and function of these control flaps is by treating them individually, although it must be borne in mind that in actual practice the control surfaces are to a large extent interdependent.

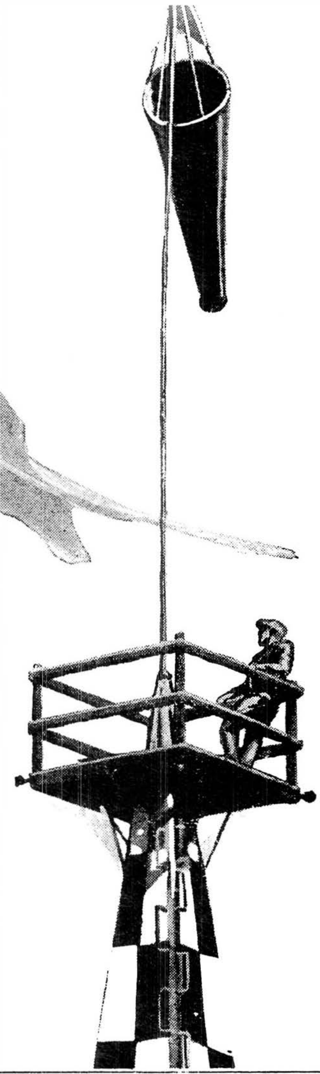
In the usual modern airplane all the control flaps are to be found at the rear of the fuselage and wings. The wing flaps, or "ailerons", are placed towards the end of the wings and serve to control the lateral movements of the plane about the axis XX as shown in Fig. 1. The two remaining sets of flaps are located in what is known as the "empennage", or, to give it the modern name, "the tail group." The elevators consisting of two horizontal flaps, are placed at the extreme end of the fuselage.

These elevators, or horizontal rudders, control the movements of the plane about the axis YY (see Fig. 1), or in simple language they control the up-and-down movement of the plane. The rudder is also located at the extreme end of the fuselage, but in a vertical position. It controls the turning or "yawing" movement of the plane about the axis ZZ (Fig. 1).

We have then the wing flaps, or ailerons, for lateral control; the elevators, or horizontal rudders, for raising or depressing the tail of the airplane, and the vertical rudder for turning. These control units are connected by means of cables or rods to a central control lever in the case of the wing flaps and elevators; the vertical rudder being connected to foot pedals or to a rudder bar. The general arrangement of these connections is clearly shown in Fig. 2. It will be noticed that the control columns, or "joy-stick", operates in such a manner as to enable the pilot to move the wing flaps by pushing the "stick" from side to side, and the elevators by pushing forward or pulling back on the same stick.

Having shown the arrangement of the control elements and explained their functions in a simple manner we will now consider the means by which each control unit achieves its purpose. The actual control of the airplane is easily accomplished by the pilot through the manipulation of the flaps described above. The ailerons or wing flaps as previously mentioned are carried at the rear extremities of the wings. They are movable and interconnected so that if one flap is depressed the opposite one automatically is raised. It is evident that as long as the flaps are held in a neutral position there will be equal lift on each wing. Assuming that the pilot depresses one flap with the consequent raising of the one on the other side, let us see what will happen. Pressure will be exerted on the lower surface





INTRODUCING THE 1930 FLYING MANUAL

This, the second or 1930 edition of Modern Mechanics' Flying Manual, *is dedicated to the proposition of disseminating practical information on aviation. It places concrete knowledge in your hands.*

No need to tell the modern air minded young man that the day of aviation is here — that the hectic development period of the air is past; everyone knows it. Aviation is beyond the primer stage.

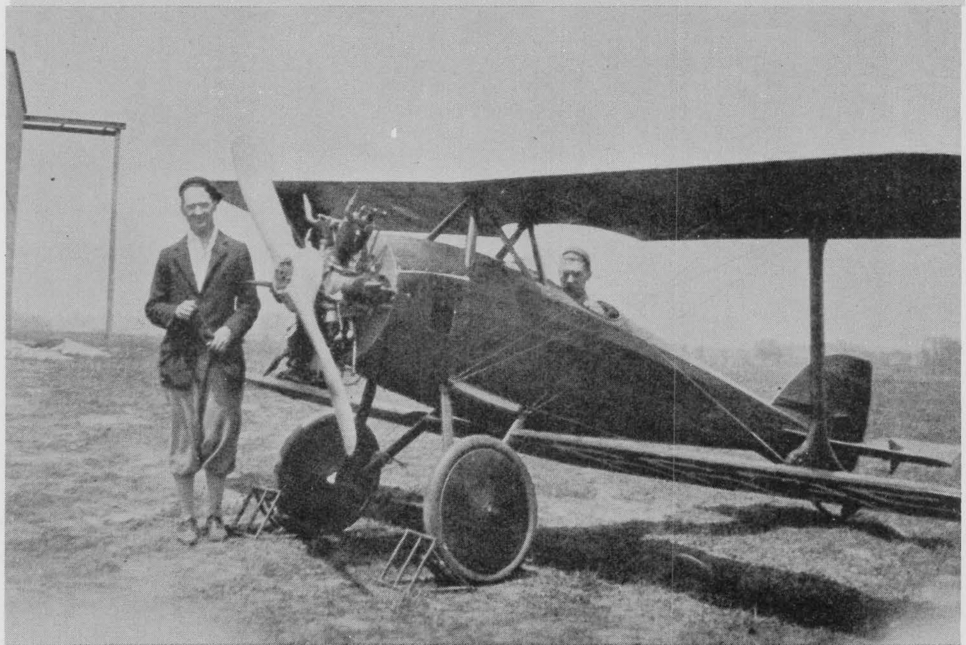
What the man of today really wants to know is mirrored in questions one hears on all sides whenever talk drifts to aviation. "What was done last year in aeronautics?" or "Where in the world can I get plans for a good, inexpensive airplane I can build and fly myself? How can I build my own engine?"

This Flying Manual *answers questions of this sort. It has been edited by experts who know what information the air-minded fans of the country want, and who can give it to them.*

Other chapters expound in simple, understandable language the latest aerodynamic information under such headings as "Choosing Your Own Wing Curve", "Lightplane Fittings", and "The Plane and Its Parts", by Weston Farmer. Plans for planes like those on the opposite page are presented in full. Stewart Rouse's story on "Building the Baby Bullet", is a classic. Directions for building your own motor appear here in print for the first time.

In short, the Flying Manual *is planned with a treat in store for every air-minded boy from 8 to 80 and bear in mind that the Editors, experts all, stand ready to supplement the* Manual *in answer to your inquiries. Hop to it!*

Fred Trump and his Lincoln Sport biplane Anzani powered. Plans on page 38.



Fred Trump Photo

THOSE WERE THE DAYS! . . . the days that gave inspiration, vision and encouragement to getting the average man airborne. The days when our non-air-minded public began to see the possibility of getting into the air at a reasonable cost. From these basement and attic workshops, from garages and barns, came new ideas from self-educated men who have contributed immensely to the advancement of today's aviation.

Today EAA, on an organized basis, is carrying on this early effort of encouraging men to put their minds to work again, to go into their garages, attics and basements using our past history, our proven techniques and new materials to produce simpler and safer aircraft and to develop low cost and economical power plants. All this to open this vast ocean of air above us.

We invite you to come and visit the Experimental Aircraft Association Air Education Museum at Franklin (Milwaukee suburb) Wisconsin and view many of these past accomplishments and to view modern lightplane progress.

We thank Fawcett Publications for the privilege allowed us to reprint this historical and enlightening publication.

PAUL H. POBEREZNY, *Pres.*
EAA Air Museum Foundation

Prepared by Paul H. Poberezny and S. H. "Wes" Schmid
Cover drawing by Douglas Rolfe

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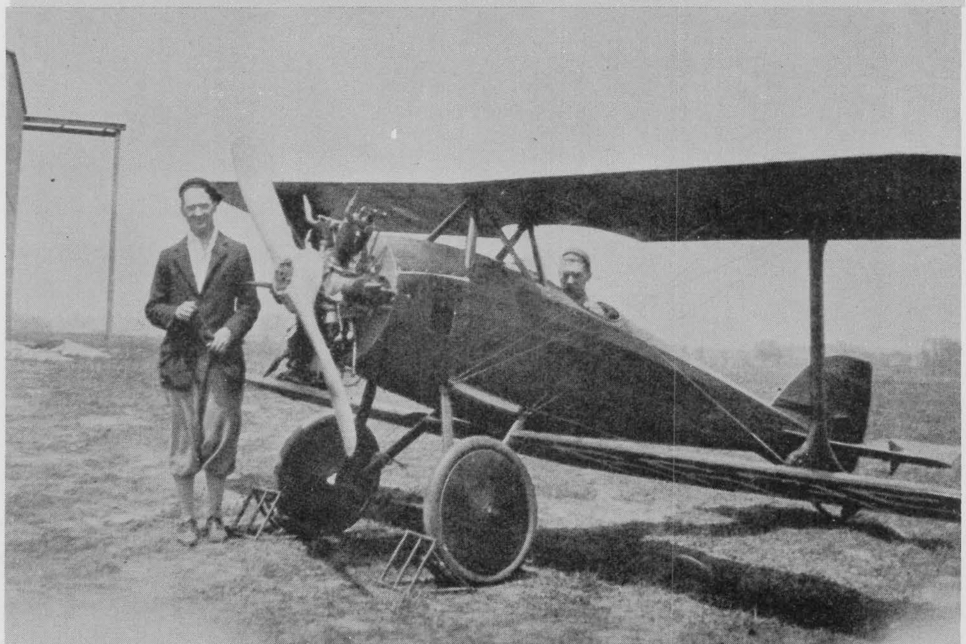

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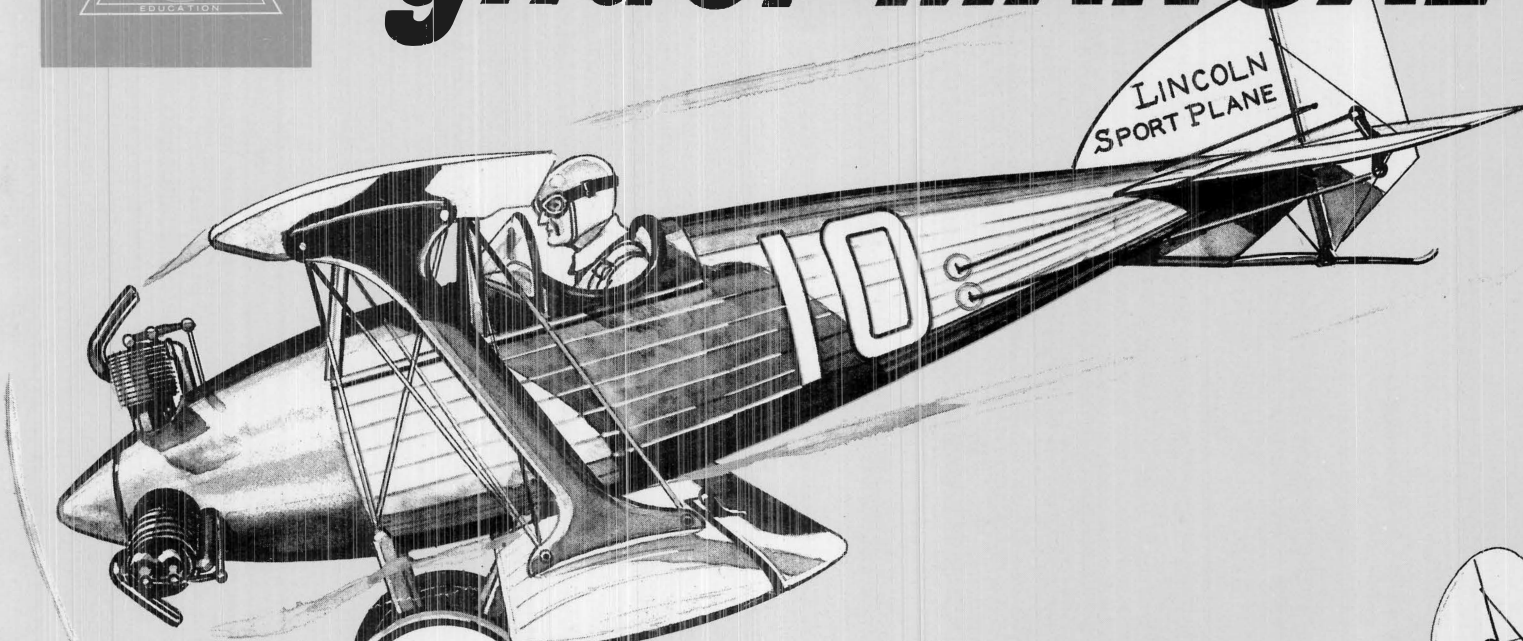
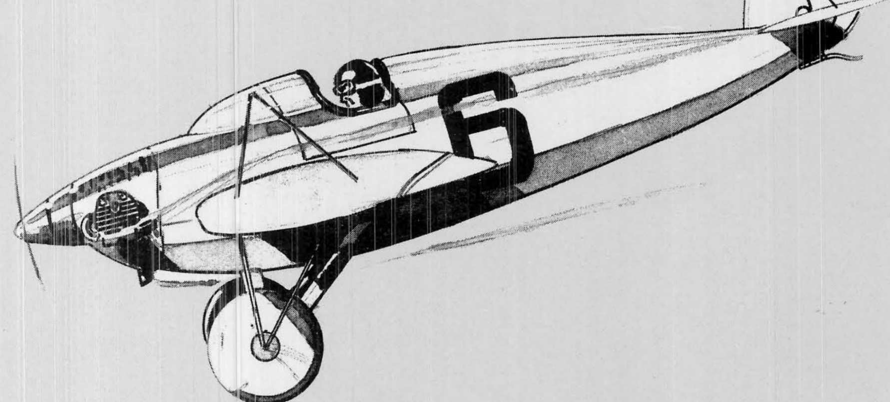
1930

FLYING and glider MANUAL





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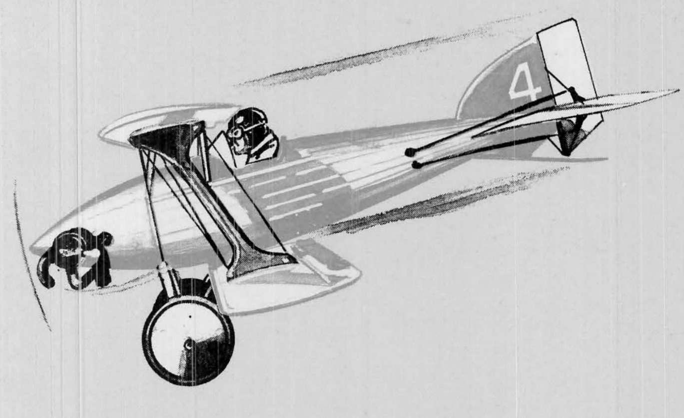

BUILD and FLY

THE SPORTPLANE AUTHORITY OF AMERICA